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APPLICATIONS OF TEXTURE PERCEPTION IN THE ANALYSIS OF COMPLEX OPTICAL IMAGERY

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HARVARD SCHOOL OF PUBLIC HEALTH

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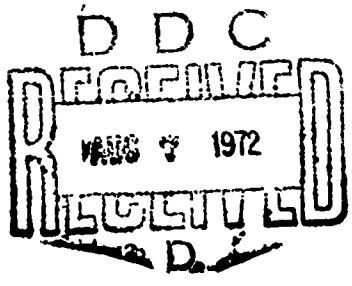

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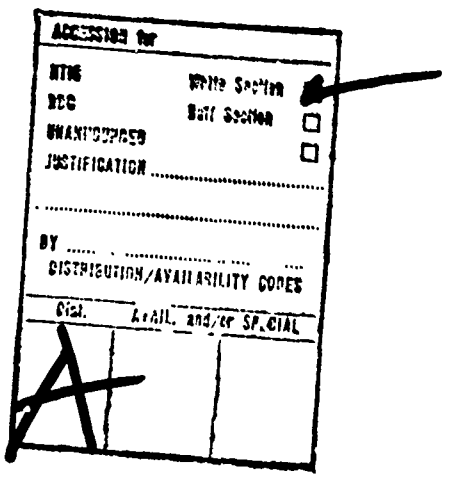

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13. ABSTRACT

These studies examine the feasibility of using texture perceptions in scientific or technical analyses of complex optical imagery. Section I illustrates that reliable quantitative data can be derived from texture perceptions, provided appropriate psychometric techniques are employed. The perceptual data have to be standardized and scaled, and then pooled and averaged over several independent observations. Section II illustrates, in the context of medical imagery screening, a procedure which may often be required to translate the idiosyncratic visual assessments of expert observers into standardized psychometric procedures, some of which might then be carried out by untrained observers. The language used by cytotechnicians in prescreening Pap smears for evidence of cancer is surveyed. Dimensions of description are abstracted and incorporated in psychometric scaling tasks. Section III reports studies of reliability and validity when observers follow psychometric procedures in measuring the over-all appearance of Pap smears. The results show that several of the texture measures obtained are reliable, and that at least one of the measures may be a valid discriminator of cancer. In addition to presenting evidence that texture perceptions may be effective, other considerations of cost and administrative convenience are presented which indicate that texture perceptions may be of practical value for routine screening operations. The report suggests that applications of texture perception could be made in a wide range of situations requiring scientific or technical analyses of complex imagery, particularly where automated assessment is not available or prohibitively expensive. A thesaurus of descriptors of complex optical imagery with 1707 entries is attached.

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visual pattern perception						
visual texture perception						
airborne visual reconnaissance						
imagery screening						
biomedical imagery screening						
solar imagery screening						
cancer						
pap smears						
psychometric methods						
language						
visual description						
subjective scaling						

FOREWORD

This study was initiated by the Human Engineering Division of the Aerospace Medical Research Laboratory. The research was conducted by the Harvard School of Public Health under Air Force Contract F33615-68-C-1147. Ronald M. Pickett, PhD, was the principal investigator for the Harvard School of Public Health. Julian O. Morrissette, PhD, of the Systems Effectiveness Branch, was the contract monitor for the Aerospace Medical Research Laboratory. The research sponsored by this contract was started in January 1968 and was completed in July 1971.

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This technical report has been reviewed and is approved.

CLINTON L. HOLT, Colonel, USAF, MC
Commander
Aerospace Medical Research Laboratory

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SECTION I
INTRODUCTION AND RATIONALE

This program was designed to study the role of texture perception in complex imagery analysis. It was aimed at developing techniques whereby texture perception can be used in imagery analysis in a wide variety of scientific and technical contexts; including contexts as diverse as medical imagery screening, aerial surveillance, and solar observing.

In visual screening of imagery, the observer usually has the option either of scanning the display in a highly focused search for critical details, or of looking more casually at the display to gain an impression of its general configuration and texture. Which option he chooses depends on the situation, which may often require a combination of the two. For example, in screening a smear of exfoliated cells for evidence of cancer, a cytotechnician will follow both options. The whole configuration and texture of a smear may provide relevant information because it can have in it residual evidence regarding histological structure of the parent tissue, which may be significantly altered if the tissue is malignant.

The textural analysis is followed by a search for critical details, such as an occasional cell with a very large nucleus. The textural analysis may serve mainly to set the tone of the detailed scan, affecting the intensity and pattern of scanning. It can make the observer more or less suspicious that the parent tissue is malignant and more or less suspicious that certain regions in the smear may contain critical signs of disease.

A two-stage approach to imagery screening is probably also common in aerial surveillance tasks as well, although not yet tested. Here, the critical details sought in the imagery may be such features as tanks or trucks, but the search for these details may be toned by impressions of the overall configuration and textures in broad regions of the display.

The same combination of diffuse and detailed analysis may occur in solar observing as well (Pickett, 1971). The solar observer scans a very complex telescopic display of the sun, trying to predict, or at least quickly detect, occurrence of a solar flare. His attention is focused on such critical cues as the shape and position of a filament lying close to an active sunspot region. But, he may also rely on diffuse impressions of the configuration of the active region as a whole. Here, however, the combined strategy may not be deliberately chosen. The observer may fall into it with experience, without being able to justify it or even articulate what he is doing. As Firor and Liliequist (1965) phrase it, the experienced observer may ultimately rely on "a certain feeling" on a recognition of characteristics of the active region that "often go unrecorded except in his mind."

Our concern in this study is the possibility of harnessing these diffuse textural and configurational analyses in a more positive way, so that they can contribute to imagery analyses, not just in setting the tone of the search for critical details, but in providing information in their own right, information that can be separately interpreted and related to other parameters of the phenomena under study. There is ample evidence that the human observer can

sense shifts in a wide variety of texture variables (Pickett, 1968, 1970). When psychometrically tested, he can produce discriminating and reliable assessments. Further, by pooling subjective reports over a number of observers, the assessments can be made more precise, and in many situations the grouped data may be useful in detecting and scaling a texture quality which individual observers would never confidently report.

The degree of precision that can be achieved in subjective assessments of texture is illustrated in a study by the author (Pickett, 1967). Figure 1 shows the computer-generated texture that the observers had to assess. The quality of coarseness that obviously varies over the three samples is controlled and specified in terms of the transition probability of a Markov process that assigned dots or spaces to adjacent cells across the rows of the matrix.

The observer's task was to assess the texture in individual samples generated at various values of transition probability (TP), and to indicate whether the texture was more or less EVEN than the criterion generated at TP=.5. The observers were told nothing about the generating process but were simply shown the criterion (MEDIUM) and the two extremes (COARSE and EVEN), as shown in Figure 1, and then allowed to work. Typically they took less than 2 seconds to process each sample, and from that fact alone we can suspect that they relied on a casual impressionistic analysis. The results, pooled over 20 observers, are shown in Figure 2. The relationship that it shows between probability of the response "EVEN" and transition probability is remarkably sensitive and systematic.

Immediately relevant to the present discussion, though not the aim of that study, is the possibility of using response probability as a subjective measure of texture. If, for example, we lost the label from one of the test samples and needed to find out what its transition probability was, we could have put it in front of our subjective measuring devices (our 20 observers) and had them make repeated independent assessments of its evenness within the confines of that psychometric task. Then, if the response probability turned out to be, say .85, we could have concluded, with a practical degree of confidence, that the transition probability of the patch was close to .56. Such is the potential for precise psychometric assessment of a texture variable.

Clearly, subjective measures of texture with this degree of precision could be scientifically and technically useful. For those many situations where automated texture analysis is beyond the state of the art, or economically prohibitive, the human observer might serve very well as the texture analyzer. For any particular problem area, it would take exploratory studies to determine whether observers could see any textural properties in the imagery that might contribute to the analysis. Then, where that was the case, psychometric tasks would have to be developed that focused assessments on the texture qualities of interest and provided appropriate response media for reading out the resulting impressions.

1. AN ILLUSTRATION OF TEXTURE PERCEPTION IN SOLAR IMAGERY ANALYSIS.

The psychometric approach is illustrated in some studies of texture perception in the context of solar observing, recently reported by the author (Pickett, 1971). The aim of these studies was to determine whether there were any

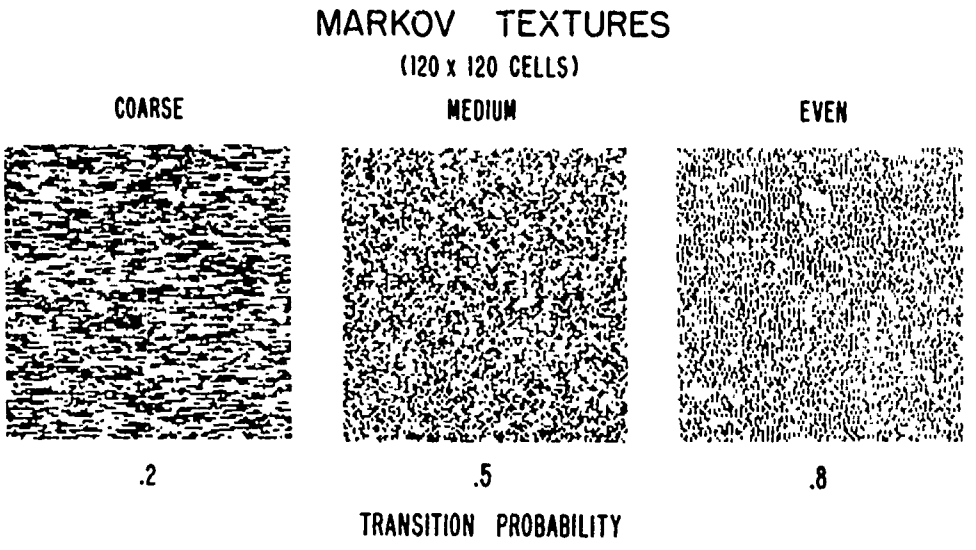

Figure 1. Examples of Markov Texture Generated in a 120 x 120 Matrix. The actual displays used were negatives of this and had considerably less sharpness of detail. (From Pickett, 1967).

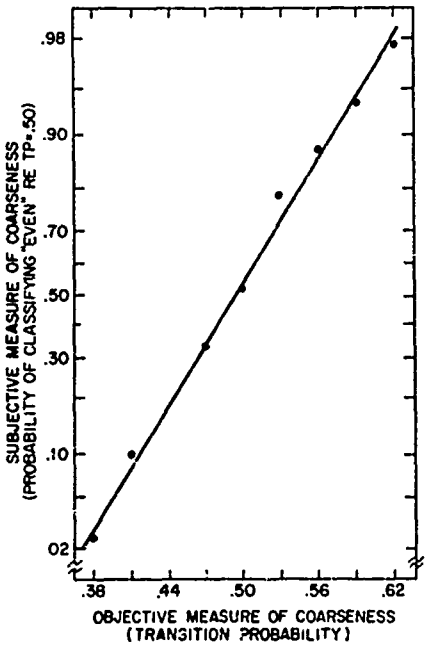

Figure 2. Response Probability. Group performance function showing the probability of EVEN responses as a function of TP for discriminations of Markov texture in a 120 x 120 matrix. (From Pickett, 1967).

visible changes in the texture of active solar regions related to the imminence of a solar flare. The observers were college students, untrained in solar physics, unaware of the problem of flare prediction, and unaware that they were examining pictures of the sun. They were shown pictures of active sunspot regions at three points in time; 9, 5 and 1 minute prior to the occurrence of a flare. In exploratory studies, conducted in a classroom setting, observers were asked to assess the texture of the active region along three dimensions, called: ABRASIVENESS, PACKABLENESS, AND SWIRLINGNESS. These dimensions were selected arbitrarily,[1] to serve simply as a way of getting the observers to assess the texture in a variety of ways, one of which might prove relevant.

One of the requirements in this psychometric approach to imagery analysis is to program each observer to carry out as nearly as possible the same perceptual task. What we seek is a situation in which precision is gained by pooling the responses of individual observers so that a desired level of precision is converged upon as the number of pooled observations is increased. If the observers are not well-coordinated, the number of observations required to achieve a discrimination at a desired level of precision may be economically prohibitive for routine screening operations. It is important, therefore, to sharply focus the analysis of each individual observer and to devise an explicit standardized task so that pooled responses converge quickly to the desired level of precision. Hence, we attempted to make explicit perceptual operations[2] for each observer to follow in making his judgments of the solar imagery.

In judging the three texture qualities, the observers were instructed to consider that the object they saw in the pictures (the solar disc) was actually about two feet in diameter, thus guiding each of them to see the object at the same scale. With regard to ABRASIVENESS, they were asked to imagine rubbing their fingers over the surface in the active sunspot region, and to estimate from the way it looked how abrasive it would feel in that tactual operation. Then they were to rank order the three time samples for each flare sequence in terms of that anticipated tactual sense of abrasiveness. To assess PACKABLENESS, they were asked to imagine dipping their hands into the material in the region of the sunspot, withdrawing a handful, and packing it like a snowball. The quality of SWIRLINGNESS was not operationally defined. They were simply asked to judge that quality based on their own individual operations.

The data showed that the observers, as a group, could sense a change in texture between nine and five minutes prior to a flare. The same statistically significant pattern of ranking was found with respect to all three qualities,

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1. In this situation as well as most others, there may be some nonarbitrary approaches. One approach is to look to theoreticians for suggestions about relevant textural dimensions. Another approach is to get hunches from experienced observers.

2. This term was chosen to suggest an analogy between operational definitions of objective measures and operational definitions of subjective ones. Every subjective measure would have to have an operational definition to be scientifically useful.

leading to the added conclusion that the observers were probably responding to a shift in the same underlying property, perhaps to a shift in a quality akin to photographic clarity or SHARPNESS.

Data from a subsequent study (Pickett, 1971) aimed specifically at the assessment of image SHARPNESS reveal statistically significant effects consistent with those earlier conclusions. The results from that study, shown in Figure 3, provide evidence that detail in active regions tend to sharpen between nine and five minutes prior to a flare and then return to a duller state just before a flare occurs.

2. DEVELOPING PSYCHOMETRIC METHODS FOR IMAGERY DESCRIPTION.

Our studies of the application of texture perception in solar imagery analysis provide some evidence that the move can be made from theory to practice. They also help to point out two steps that have to be taken. The first is to find a language of textural description appropriate to the specific application. In the exploratory studies mentioned above, we chose the descriptions arbitrarily, but as we pointed out, there are some nonarbitrary ways, one of which is to get hunches of relevant textural descriptions from experienced observers. The next step is to carry out psychometric tests to determine the reliability, validity, manipulability, and cost of the proposed subjective texture analyses. We consider points relevant to each step here in brief general discussions. In the other two sections of this report we show how we have taken each step in applying subjective texture analysis to a specific problem in medical imagery screening.

As we undertook the work described in Section II, we had in mind several ideas about the role of language in pattern perception. We had first in mind that there is abundant evidence to support the view that language affects what a person sees (Gibson, 1969). The usual explanation is that the observer rarely abstracts all the information in a pattern in the process of recognizing or discriminating it, that language can affect which part he takes and, accordingly, affect what he sees. Descriptive labels presumably bias the way the observer looks at the pattern, how he scans it and what feature he notices.

Another explanation of the effect of language, perhaps more pertinent to the present discussion, is that language may affect how the optical information is processed. Processing the information in a pattern may be compared to processing the information in a table of numbers. There are obviously many ways that the data in the table can be processed to obtain a descriptive abstract. Even if the observer were to take into account the great bulk of features in an image, as we suggest in the process of texture perception, he may have alternate ways of processing that data that are determined by language. In our solar imagery studies, we considered such a possibility, and attempted to program the observers to process the same texture data; one way with the ABRASIVENESS instruction, and another way with the PACKABLENESS instruction.

Another point we had in mind was that language may affect perception by keeping the observer's descriptions more or less close to his phenomenal experiences. For example, the author has been fascinated to find solar observers describing a change in brightness of a feature on the solar disc as a movement. What they mean is that the change in brightness is due to a Doppler shift which

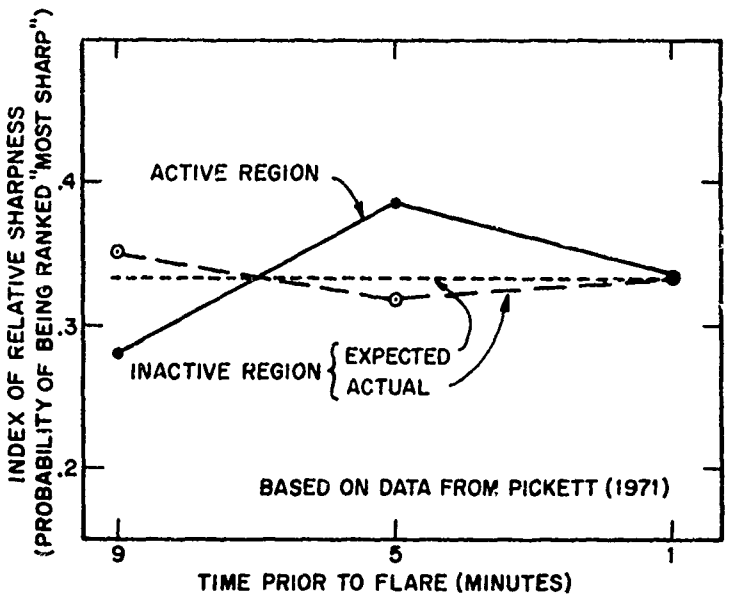

Figure 3. Psychometric Evidence of a Visible Change in the Texture of Active Regions Shortly Before Occurrence of a Solar Flare. Data from subjective impressions of image SHARPNESS at three points in time preceding a flare, for: (a) active regions; and (b) inactive regions on the same frame of the film record. Also shown is the expected index, if SHARPNESS varies randomly over time and is unrelated to flare occurrence. Based on data from Tables 5 and 7 in Pickett (1971).

in turn, indicates that the feature is moving vertically. This is a good example of a situation that is probably very common in many scientific and technical contexts where language of theory displaces the language of phenomenal experience. In this particular example from solar observing, it poses no problem beyond confusing neophytes, but in other situations such translations may pose serious problems; for example, problems in training. Instruction about relevant dimensions and features of the imagery could become so steeped in theoretical language that teachers and students alike might lose some capacity to talk about what the display really looks like in phenomenal terms.

The translation could be ultimately problematical, of course, if the theory underlying the theoretical descriptions was wrong. For psychologists, this problem is perhaps most succinctly described by referring to the classical issue of the stimulus error, i.e., describing the stimulus in terms of its logically expected properties as opposed to describing the actual phenomenal experience.

Another important consideration was selecting languages compatible with the basic functions of texture perception. In previous reports (Pickett, 1968,

1970) the author has suggested that texture perception may serve the basic purpose of providing impressions of substance, structure, and perspective in the terrestrial visual world. If so, then the most efficient way to harness texture perception may be to frame the imagery processing task into some kind of substantive or structural description of the image. This view has tempered, but not dominated, the otherwise empirical approach.

As far as the work covered in Section III is concerned, the general considerations were largely traditional for the kind of psychometric studies reported there. With the language work completed and the observers equipped with appropriate perceptual operations, the next step is to evaluate their performance. This is done in the same general sense that one would test an objective measuring device. First, there is the need to establish whether the observers can discriminate variations in the imagery under study and do that reliably. Next is the need to determine whether their discriminations are valid, in the sense of relating to properties of the phenomenon being displayed that are of scientific or technical interest. Then, it would be important to see whether their analyses can be finely tuned or focused in systematic ways to maximize sensitivity to the relevant textural variations. Finally, there is the need to check on effects of several factors peculiar to the human observer, namely: learning, motivation and fatigue. Each of these aspects of performance can be evaluated in appropriately designed psychometric studies, and several are, in fact, considered in the work reported in Section III.

SECTION II
STUDIES OF THE LANGUAGE OF TEXTURE PERCEPTION IN MEDICAL IMAGERY SCREENING
(Pap Smear Description)

Detection of disease through microscopic inspection of smears of exfoliated tissue has been recognized as an invaluable clinical technique (Koss, 1968). Its increasing routine use in medical examinations accounts for a large part of the phenomenal growth in the workload of medical laboratories over the last 20 years. This technique capitalizes on the fact that dead cells, shed from tissue, can provide evidence of disease in the tissue from which they were shed. To study the cells under a microscope, they are smeared over a microscope slide and then stained and fixed in a variety of ways, most commonly by the Papanicolaou (1954) method (Pap smear).

What is particularly valuable about Pap smears is that they provide a way to study the condition of internal organs without surgical exploration because exfoliated cells accumulate in accessible body fluids that derive from a number of organ systems. This technique is particularly valuable in searching for evidence of cancer, and while it is useful in detecting that disease in a number of organ systems, including the stomach and lungs, it has proved to have its greatest use in the detection of uterine cervical cancer. The screening of Pap smears for this purpose alone has become a task of enormous and growing proportion.

Pap smear screening is primarily a matter of visual assessment of the cellular specimens under a microscope. They appear as masses of cellular designs characterized by various qualities of coloring, shape and arrangement (see Figure 4). Through extensive training and on the job experience, cytotechnicians learn how to scan and interpret such visual patterns to detect and identify disease in the sampled tissue. The technique may have its personalized variations, but typically the screener starts with comprehensive analysis of the display, which we refer to here as prescreening, and then goes on to more detailed and localized analyses.

Prescreening serves two multifaceted functions. One function is to provide a basis for tempering subsequent detailed interpretations of the display by taking into account the conditions under which the specimen was taken and prepared. Variations in the conditions may have effects on the appearance of the specimens that are unrelated to the presence or absence of disease and so detailed interpretations have to be tempered by taking those normal variations into account. The other function is one of gaining some general feelings or hunches about whether the sampled tissue is normal or abnormal. The basis for such hunches may be very difficult for the screener to express in purely visual terms, let alone justify in terms of medical theory. Yet those hunches may have a practical degree of validity in themselves, and undoubtedly have effects on the detailed scanning that follows.

Our concern in the ensuing work here, and in Section III, was to see whether we could sharpen and enrich the prescreening assessment through appropriate psychometric techniques. The aim of Study I was to determine whether cytotechnicians had a consistent language for describing background qualities

relevant to the presence or absence of disease. In Study II we asked naive observers to describe the appearance of Pap smears to check whether cytotechnicians were describing properties of the image as they saw it or whether their

Figure 4 A Microscopic View of a Papanicolaou Smear of Uterine Tissue, Photomicrographed at 100x.

descriptions were based on other scientific and technical knowledge privy to them as professionals.

1. STUDY I. A SURVEY OF THE ADJECTIVES USED BY CYTOTECHNICIANS TO DESCRIBE THE OVERALL APPEARANCE OF PAP SMEARS.

a. Subjects. The subjects were 38 cytotechnicians (including 10 students) working in hospital laboratories in the Boston area who served voluntarily and without pay. Forty cytotechnicians were contacted; two declined taking the test.

b. Method. The test was administered in the form of a questionnaire consisting of a checklist of 62 adjectives. The subjects were asked to work on the questionnaire independently, checking each adjective as a visible or nonvisible quality in the overall appearance of a smear seen at 100x magnification. For an adjective checked as visible, the format called for an additional categorization with respect to whether: (a) it suggested the smear was

negative, (b) it made them suspicious or (c) it suggested the smear was positive. The questionnaire is included with this report as Appendix A. The data were tabulated to determine for each adjective the number of subjects who checked each of the possible categories. (The data from categories b and c were pooled.) We then identified each adjective in which there was a statistically significant preponderance of votes in one or another of the categories.

c. Selection of Adjectives. Several of the adjectives were suggested in prior discussions with a cytologist. Most of them, however, were chosen from a much longer list of adjectives; an early version of the lexicon included with this report as Appendix B. We tended to choose adjectives that would be descriptive of apparent substantive and mechanical properties of the material. This tendency was largely dictated by the consideration, mentioned in Section I, of the basic function of texture perception. We assume that one of the natural and reflexive responses of the visual system to any complex display is to provide immediate impressions of its substantive and mechanical meanings. These impressions, we assume, are what provide the observer in the normal terrestrial environment with a physical sense of objects in his immediate field of view and which provide, in real time, a basis for safe and efficient physical behavior. Textural impressions, we assume, are answers to implicit questions raised and answered automatically in a context of chronic uncertainty about the immediate physical environment, an uncertainty which is shared by all observers, scientifically sophisticated and naive alike, and which is largely unaffected by an intellectual understanding that the display has no environmental significance (see Pickett, 1968, 1970 for further discussion).

d. Results. The results are shown in Table I. Listed are each of the adjectives which received a statistically significant majority of votes by a Binomial test ($p < .05$, two-tailed) in each of the possible categories.

e. Discussion. Perhaps most informative is the surprisingly large number of qualities which the observers claim are visible (32 out of 62) and relate to the presence or absence of cancer (21 out of 32). Also of possible significance is the fact that there are a greater number of positive than negative descriptions. But, perhaps most relevant to the present aim is the possibility of abstracting several qualitative dimensions for psychometric study. The approach was to make several obvious pairings between the positive and negative lists in the visible category, e.g.:

	Negative	Positive
Qualitative dimension	Calm	- Explosive
	Clean	- Dirty
	Consistent	- Variable
	Dull	- Bright
	Loose	- Tight
	Transparent	- Opaque

In this way several dimensions of textural description presented themselves for psychometric study. Others, like the quality Pliable-Extrudable, which placed in neither the visible nor the nonvisible category, were chosen by the author for psychometric study on the basis of his own hunches.

TABLE I

RESULTS OF A WORD SURVEY ON A SAMPLE OF CYTOTECHNICIANS

	Agreed on, by the majority of those who said they were visible, to suggest:		Not agreed by those who said they were visible to suggest either positive or negative
	NEGATIVE	POSITIVE	
Qualities Agreed* on by the Majority as <u>VISIBLE</u>	Calm Clean Consistent Dull Loose Regular Transparent	Bright Clumped Dirty Enmeshed Explosive Fibrous Lumpy Matted Opaque Pearly Puffy Thick Tight Variable	Cohesive Compact Fatty Filmy Fragile Granular Lustrous Shrunken Shiny Spongy Waxy
Qualities Agreed*on by the Majority as <u>NOT VISIBLE</u>		Gummy Leathery Pulpy Ropy	Creamy Doughy Droopy Slippery Starchy
Qualities Not Agreed on by a Statistically Significant Majority as either visible or not visible	Firm Pliable Silky Soft Velvety	Crumbly Extrudable Gluey Hard Raw Slimy Soapy Stiff	Brittle Elastic Floating Milky Oily Pasty Rubbery Sticky

*Significant at the 5% level assuming equiprobability of assignment to the two alternative classifications.

2. STUDY II. A SURVEY OF ADJECTIVES USED BY NAIVE OBSERVERS TO DESCRIBE THE OVERALL APPEARANCE OF PAP SMEARS.

The aim of this study was to give a test to naive observers, equivalent to that administered to cytotechnicians, so that we could compare their descriptive languages. As noted in Section I, it is probable that professional observers contaminate descriptions of their phenomenal experiences with descriptions based on other theoretical and technical knowledge of the phenomenon under study.

a. Observers. The observers were 47 undergraduates in two psychology classes at Northeastern University, 24 in one class and 23 in the other. They participated in the survey as a class exercise.

b. Method. The 24 students in one class were shown views only of negative Pap smears while 23 students in the other class saw similar views, only of positive smears. Each of the observers was given a checklist containing the same 62 adjectives used in Study I, but in this case the format called only for classifications of visible and nonvisible. They were asked to study the pictures that were shown, and then to check those adjectives only with respect to whether they were descriptive of visible or nonvisible qualities. The subject matter of the pictures was not described to them in any way, and they were asked to avoid any discussions among themselves about the pictures. Inquiries after the test revealed that many of the students felt sure they were looking at microscopic displays, and some were sure they were looking at biological specimens of some kind. None mentioned any knowledge of Pap smears or Pap smear screening.

The observers were told that their performance was going to be compared to that of a large number of professional observers, very experienced from looking at thousands of such pictures, who also had taken this test. They were also told that the professional observers had selected about half of the words as describing a visible quality in pictures of this kind. Then they were told that they would be paid, on the basis of their individual performance, 2¢ for each case where their classification was in agreement with the professional observers. They were actually scored in terms of their agreement with the statistically significant classifications shown in Table I. The data were analyzed in the same way as in Study I.

c. Stimuli. The stimuli were color photomicrographs taken from selected regions on 20 different Pap smears obtained from one of the local teaching hospitals. They had been previously screened in the cytology laboratory for evidence of uterine cancer with 10 of the smears classed as positive (squamous carcinoma) and 10 negative. The smears were standard preparations on microscope slides, photographed in color at 100x magnification. Photographs were made of 10 systematically selected areas on each smear according to the plan shown below:

ID#					
	1	2	3	4	5
	6	7	8	9	10

Thus, there was a working sample of 100 negative and 100 positive images which were prepared as 35mm projection transparencies, and used for all the studies described in this report. From one study to the next the same smears were used, but the particular views were varied. In this study views 3, 4, 5, 6, 7 and 8 were used. The 60 images (six views of 10 negative or 10 positive smears) were shown two at a time on a screen at the front of the classroom, by use of two Kodak Carousel projectors. The sequences were arranged such that a different smear was represented in each of the paired views, and the 10 smears were represented on each sequence of 10. The 60 images were cycled continuously as the test proceeded, with each pair displayed for approximately 10 seconds. The test was completed in one class hour.

d. Results. Wherever the majority of the observers in both groups agreed on the same word, we pooled their data. If the majorities did not agree, we treated their data separately. If a word received a statistically significant majority ($p < .05$, two-tailed) in one way or another, it is listed in Table II. In the top row of Table II are those words agreed upon by a majority in both the positive and the negative group to be visible qualities of the Pap smears. There was one word, "creamy," where the majorities did not agree but where the separate and oppositely voting majorities were statistically significant.

e. Discussion. Perhaps the most interesting finding is that there is considerable disagreement between the naive and professional observers. (The asterisked words in Table II are those on which they disagree.) The naive observers say, in disagreement with the cytotechnicians, that "doughy" and "slippery" describe visible qualities of Pap smears. This may only mean that the cytotechnicians see these qualities but use other words to describe them. On the other hand, there are interesting possibilities that the cytotechnicians do not see these qualities or, if they do, that for one reason or another, they inhibit describing them. If the latter situation is true, then the cytotechnician may be inhibiting descriptions of qualities that are potential discriminators. We have one possible example of that here with the quality, "creamy."

In row two of Table II we see that the naive observers claim that "consistent," "dirty," "dull," "lustrous," "regular," "tight," and "waxy" do not describe visible qualities, whereas the cytotechnicians say they do. Again, this may be due to differences in use or meaning of these words. On the other hand cytotechnicians may be reading into smears qualities which are not there but which they are led to believe are there from other knowledge acquired in their professional experience.

Our interpretation of these findings has to be tempered by at least three general considerations. Even if there were no real effects in the data, we would expect to find statistically significant effects at the 5% level about 5% of the time. Perhaps more important, the sample of positive and negative smears that the naive observers based their judgments on may be far from typical of the vastly larger sample of smears that the cytotechnicians based their judgments on. Finally we need to consider limitations on the adjective checklist. It certainly is not an exhaustive, nor even a representative list, of all adjectives which might be useful for describing smears. A thorough language inventory would require a comprehensive checklist and the approach would be to take a series of surveys beginning with a survey of general categories of description and ending with a survey of fine distinctions within

TABLE II

RESULTS OF A WORD SURVEY ON A SAMPLE OF NAIVE OBSERVERS

Qualities Agreed** on by the Majority as VISIBLE	Bright	Loose
	Clumped	Opaque
	Cohesive	Pliable
	*Doughy	Slimy
	Enmeshed	*Slippery
	Filmy	Transparent
	Floating	Variable
	Granular	
Qualities Agreed** on by the Majority as NOT VISIBLE	Brittle	*Lustrous
	*Consistent	*Regular
	*Dirty	Ropy
	Droopy	Stiff
	*Dull	*Tight
	Firm	Velvety
	Hard	*Waxy
	Leathery	
Qualities Agreed** on by the Majority of: (1) Those who viewed positive slides as VISIBLE; and (2) Those who viewed negative slides as NOT VISIBLE	Creamy	

*Opposite to the judgment of cytotechnicians.

**Significant at the 5% level assuming equiprobability of assignment to the two alternative classifications.

those categories found to be relevant. The development of a lexicon of visual descriptions would be the first step in that direction, which we have since attempted to take (see Appendix II). Despite the limitations, however, these studies exemplify a systematic approach to an inventory, and they did yield productive leads for the studies reported in Section III.

SECTION III
PSYCHOMETRIC STUDIES OF TEXTURE PERCEPTION IN MEDICAL IMAGERY SCREENING
(Prescreening Pap Smears)

The studies reported below are an attempt to put into practice the ideas outlined in Section I. The immediate goal is to determine whether there is any potential for practical applications of texture perception in prescreening Pap smears for evidence of cancer.

There are several ways to carry out psychometric tests of subjective qualitative descriptions. A comprehensive treatise on psychometric methods is provided in Guilford (1954) and two approaches are illustrated in Section I of this report. Here we take yet a third approach employing a set of standardized subjective scaling tasks. The observers are instructed to focus their attention on the imagery in various ways to gain impressions of particular texture qualities. They then indicate the degree of the quality that each image has by assigning it a number on a scale from 0 to 9. Their subjective measures are then run through statistical analyses to evaluate reliability and validity. Some comparisons of effects across studies also provide evidence of the effects of instructions and training.

We report three studies, coded in the report as Studies III, IV, and V. In each study the observers make several individual textural assessments of the same set of positive and negative smears. In Study III, naive observers make six textural assessments. In Study IV, other naive observers make four assessments, two of which are the same as in Study III, except for minor variations in scale format and instructions. In Study V, the observers are student cytotechnicians who make the same judgments and carry out the same tasks as the naive observers did in Study IV. In Test 1 of Study V, we report assessments made by those students on their first day of training, so that, at that point, they too can be considered naive observers. In Test 2 of Study V, we report their assessments in an identical test made after six months of classroom and on the job training.

1. GENERAL METHOD.

Group testing techniques were employed. Where the observers were college undergraduates, they took the test as part of a classroom exercise. The general approach was to show pictures of smears in the form of 35mm slides, which were projected on a screen at the front of the group testing room. Each slide was a partial view of a smear photomicrographed at 100x. Over the series of slides, the observer saw several different views of 10 positive and 10 negative smears. Each slide was displayed for approximately 12 seconds, during which time the observer was required to make two separate texture appraisals, and mark the subjective scale number derived from those appraisals on an answer sheet. Depending on the study, the observer went through the whole set of slides two or three times to make all of the required appraisals which were counterbalanced to control the effects of fatigue, i.e., half of the appraisals of a particular quality were made in the first part of the test and half in the last part of the test.

a. Stimuli. The stimuli were the same ones described in Section II 2.

b. Data Reduction and Analysis. The general approach to data reduction is to determine the mean subjective scale value for each smear over all views and all observers. The first step in data analysis is to perform statistical tests of reliability. For each individual study, evidence of reliability is indirectly assessed by computing a matrix of Spearman Rank Order correlations (see Siegel, 1956, pp. 203-213) for all possible pairings of dimensions. A significant correlation is considered evidence of reliability in the sense that, if observers were unreliable in their individual assessments, it would preclude the inter-observer consistency required for such a correlation. Direct estimates of reliability are made in two situations, where the mean scale values derived from separate studies could be correlated.

The second step in data analysis is to perform tests of validity. In each of the studies we first look for differences between positive and negative smears in distribution of the mean scale reading for each dimension. We employ Mann-Whitney U tests to determine the statistical significance of those differences.

We next consider the possibility that differences between positive and negative smears might be evident in interactions between dimensions; their distribution in 2-space is now examined. The data are first plotted in each of the 2-spaces formed by all possible pairings of the dimensions and then the plots are inspected for evidence of separation between positive and negative smears. The tendency to separate is defined by the following objective procedure: (1) A straight line is drawn through the space in such a way that the smears are maximally separated, i.e., divided into the most unlikely partition, in the sense of Fisher's exact test (see Bradley, 1968, pp. 195-196); and (2) Those spaces are accepted as indicating evidence of separation if the probability of the partition is less than $p < .05$, two-tailed. Note that this probability measure is not presented as an index of the true probability of the partition, but merely as an objective criterion of separation. Statistical significance of the separation has to be sought in determining the likelihood of its repeated independent occurrence.

Beyond these two basic tests, there are a number of comparisons between performance on positive and negative smears where differences can be treated as evidence of validity. For example, a systematic difference between positive and negative smears in consistency or reliability would indicate that the observer in some sense saw the positive smears differently than the negative smears. Such comparisons are made where appropriate.

2. STUDY III. A PSYCHOMETRIC EVALUATION INVOLVING SIX DIMENSIONS OF TEXTURE ASSESSMENT MADE BY NAIVE OBSERVERS.

In this study the observers assessed background qualities along six dimensions: DIRTINESS and DULLNESS of the scene as a whole; EXPLOSIVENESS and LOOSENESS of clusters of cells in general; and DOUGHINESS and BRITTLENESS of cells in general. Each of these dimensions was defined by a pair of words suggested in Study I, representing extreme positions along the dimension. No anchor points, such as the position of common objects along the scale were provided, nor was any unit of measurement provided. Aside from general directions on how to proceed and guidelines regarding the three levels of analysis, no perceptual

operations of any kind were suggested. The observers were left to their own devices and had to develop their perceptual operations independently. The primary aim of this study was to establish a base line of task definition, a level beyond which, presumably, one could improve performance by providing explicit perceptual operations.

a. Observers. The observers were 24 undergraduates at Northeastern University, untrained in cytology, who volunteered to participate in the experiment as part of a class exercise in a psychology course on perception.

b. Method. Views 1, 3, 4 and 8 were used as the stimuli. The first 20 presentations, View 1 from each of the 20 smears, was a practice run. The next 60 presentations (Views 3, 4 and 8) were test stimuli. Within each sequence, views of the positive and negative smears were randomly ordered and the sequence of 80 views was presented three times. For half of the observers, the first time through the 80 presentations they made Scene analyses, the second time through, Cluster analyses, and the third time through, Cell analyses. For the rest of the observers the order was reversed (Cell, Cluster, Scene). Discarding the practice sequence, each observer made a total of 60 judgments (three for each of the 10 positive and 10 negative smears) on each dimension.

c. Instructions. The observers were told: (1) That the experiment was aimed at harnessing "natural" perceptions for scientific and technical purposes; (2) That they would be looking at some tissue photographed through a microscope; (3) That some of the slides would be from patients who had cancer and some from healthy controls; (4) That the test would be tedious and they did not have to participate (a few of the students did choose to take that option and left before the experiment started); (5) That the experimenter would be back to explain further about the experiment and show them the results.

The observers were then supplied with answer sheets and the scaling format shown in Table III. The levels of analysis were illustrated by pointing out features on several sample views of the smears. They were asked to make the two assessments at one level of analysis of each view each time it was presented and to indicate their assessments of each view by marking on the answer sheet the positions that they felt it occupied on the appropriate scales. No definitions or criteria regarding the dimension or the assessment procedure were provided beyond what was evident in the scaling format. Each observer had to determine his own criteria and perceptual operations and apply them independently.

d. Results. The mean scale value for each smear, averaged over all views and observers, is shown in Table IV.

Evidence of Reliability. If the observers were assigning scale values to the smears randomly and independently, we would expect homogeneity among the mean scale readings in Table IV with the scores tending to be near a scale value of 4.5. Inspection reveals, to the contrary, considerable variability both within and between dimensions, providing our first subjective indication that the assessments probably are discriminating and reliable. The inhomogeneities between dimensions suggest that the observers are doing different things in analyzing the different dimensions, but doing those different things with sufficient consistency from one observer to another for the inhomoge-

TABLE III

FORMAT FOR SCALING TEXTURES (STUDY III)

						SCENE							
1	Clean	0	1	2	3	4	5	6	7	8	9	Dirty	1
2	Bright	0	1	2	3	4	5	6	7	8	9	Dull	2
						CLUSTER							
3	Calm	0	1	2	3	4	5	6	7	8	9	Explosive	3
4	Sticky	0	1	2	3	4	5	6	7	8	9	Loose	4
						CELL							
5	Filmy	0	1	2	3	4	5	6	7	8	9	Doughy	5
6	Pliable	0	1	2	3	4	5	6	7	8	9	Brittle	6

TABLE IV

MEAN SUBJECTIVE SCALE VALUES (STUDY III)

Slide #	DIRTINESS	DULLNESS	EXPLOSIVE-NESS	LOOSENESS	DOUGHINESS	BRITTLENESS
			Positive Smears			
2	5.74	4.38	5.55	4.17	5.38	5.67
9	5.57	6.31	3.81	5.39	4.03	4.66
12	5.18	3.97	4.99	3.93	4.04	4.26
15	4.77	4.42	4.21	5.06	4.43	4.86
18	5.44	4.38	6.46	2.56	4.54	3.38
19	5.99	4.55	5.10	4.45	4.91	4.50
24	6.36	4.78	5.37	3.64	4.48	4.68
26	6.72	4.92	6.36	3.16	4.82	4.32
38	6.00	4.30	5.80	3.93	4.91	4.85
45	5.67	4.74	5.08	4.35	4.55	4.12
			Negative Smears			
3	5.86	5.23	4.59	4.63	4.74	4.54
4	4.07	4.28	3.99	4.56	3.73	5.59
5	5.76	6.01	3.88	4.92	3.47	3.91
7	6.65	5.07	5.96	3.07	4.07	4.81
10	3.50	3.72	3.67	4.11	4.21	5.25
11	4.62	4.16	4.80	3.65	4.78	5.34
13	4.89	4.44	4.10	4.11	4.48	4.33
14	4.60	4.46	4.31	3.78	3.96	4.24
16	6.63	5.61	5.90	2.26	5.63	3.59
20	5.81	3.63	6.33	2.07	4.46	3.77

neities to become apparent. The same can be said for the inhomogeneities within dimensions. They suggest that the observers see differences among the smears but see those differences with sufficient consistency from one observer to another for the inhomogeneities within dimensions to become apparent.

Our first step in providing objective evidence of these effects is to compute correlations between dimensions, pointing out that significant correlations would not be expected to occur unless the observers were seeing differences among the smears and seeing those differences in consistent fashion from smear to smear and dimension to dimension. The matrix of correlations between dimensions in Table V shows that there is a statistically significant correlation between LOOSENESS and EXPLOSIVENESS in both negative and positive smears; a significant correlation between EXPLOSIVENESS and DIRTINESS in the negative smears and between EXPLOSIVENESS and DOUGHINESS in the positive smears. Beyond those particular effects, there is general evidence of consistency in the fact that 14 out of 15 cells above the diagonal have matching sign counterparts below the diagonal. This similarity in patterns of correlation between the two sets of data is further indirect evidence of reliability.

Evidence of Validity. We sought evidence of validity first by conducting Mann-Whitney U tests of difference in distribution between the mean scale value for positive and negative smears. There were no statistically significant effects.

The next step in testing validity was to plot the data in all possible 2-spaces. We then inspected those plots for evidence of separation of positive and negative smears, in the sense described in the General Method section (III-1b). Only three of the 15 possible 2-spaces provided such evidence, and they are shown in Figure 5.

TABLE V
SPEARMAN RANK ORDER CORRELATIONS BETWEEN DIMENSIONS (STUDY III)
(Correlations for positive smears lie above the diagonal;
those for negative smears lie below)

	DIRTINESS	DULLNESS	EXPLOSIVENESS	LOOSENESS	DOUGHINESS	BRITTLENESS
DIRTINESS	--	.38	.54	-.38	.57	.14
DULLNESS	.54	--	-.20	.25	-.21	-.09
EXPLOSIVENESS	.72*	-.05	--	-.83**	.64*	-.18
LOOSENESS	-.35	.36	-.80**	--	-.20	.39
DOUGHINESS	.35	-.08	.49	-.46	--	.25
BRITTLENESS	.52	-.39	-.34	.33	-.16	--

*Significant at $p < .05$, two-tailed

**Significant at $p < .01$, two-tailed

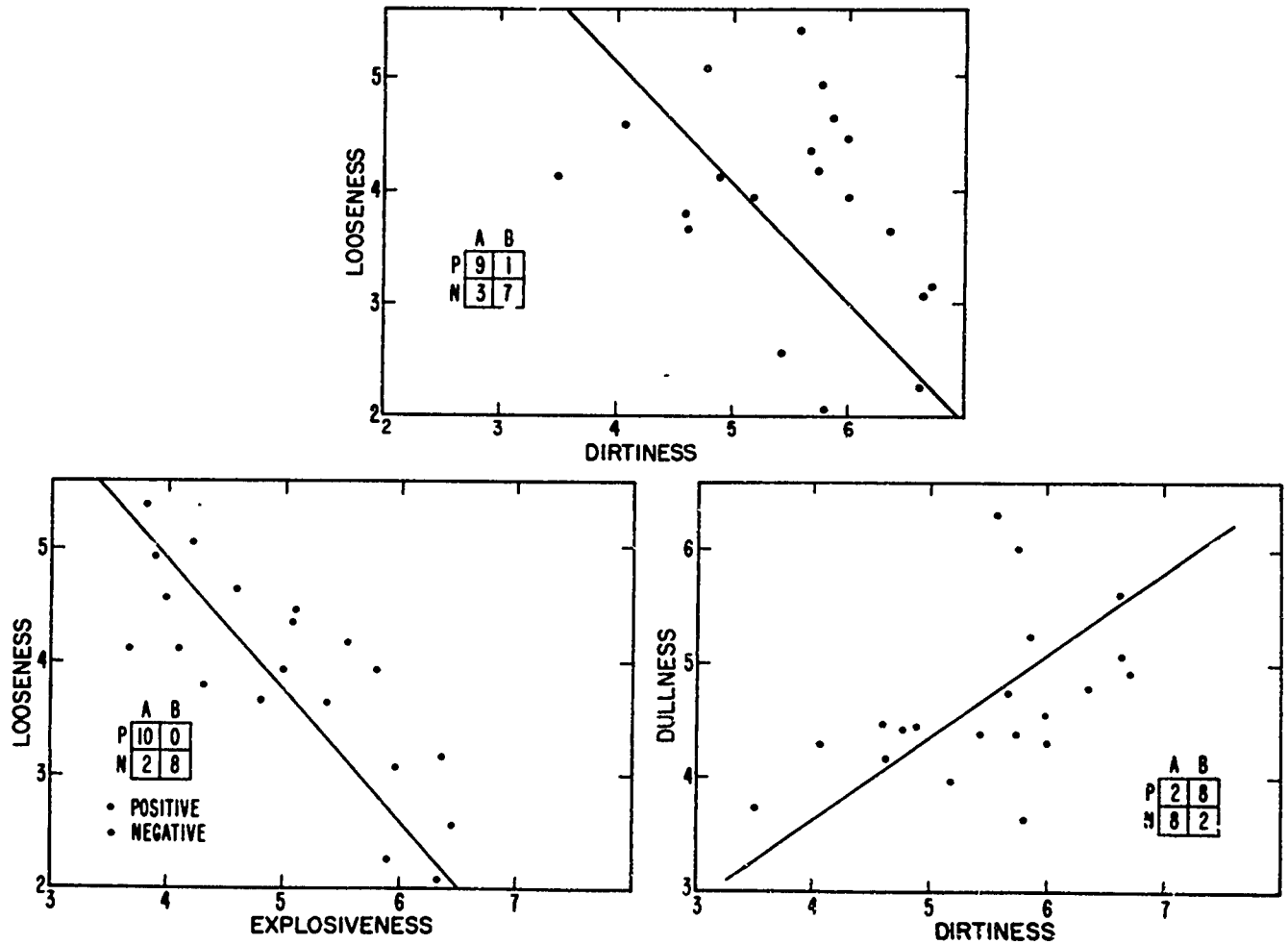

Figure 5. Potentially Useful Decision Boundaries for Identifying Suspicious Smears in Prescreening. The straight line drawn through each space partitions most of the positive from most of the negative smears. The number of positive and negative smears falling above or below the decision boundary are shown in a 2x2 table. (Study III)

In each case, inspection of the plot revealed the possibility of drawing a straight line through the space, which would partition most of the negative from most of the positive smears. For example, in the 2-space defined by EXPLOSIVENESS and LOOSENESS, 10 out of 10 positive smears lie above the line and eight out of 10 negatives lie below the line. If repeated tests with other smears showed that a boundary drawn through the space in this same way repeatedly described the same form and degree of separation, then such a boundary could prove useful in prescreening. Any smears falling above the line could be considered more suspicious than those falling below the line and, hence, to be treated to a more thorough evaluation in subsequent screening.

3. STUDY IV. A PSYCHOMETRIC EVALUATION INVOLVING FOUR DIMENSIONS OF TEXTURE ASSESSMENT MADE BY NAIVE OBSERVERS EQUIPPED WITH RUDIMENTARY PERCEPTUAL OPERATIONS AND SCALING ANCHORS.

In this study another group of naive observers assessed four texture qualities in the Pap smears: OPACITY, EXTRUDABILITY, EXPLOSIVENESS and LOOSENESS. The procedure was similar in all respects to that followed in Study III, except that in this study the observers were provided with a more definite task and some rudimentary perceptual operations.

a. Observers. The observers were 70 young women, all untrained in cytology, and students at Northeastern University in programs for nursing or dental technology. They participated voluntarily as part of a class exercise in an Introductory Psychology course.

b. Method. The observers assessed the texture qualities in six views (1, 2, 4, 5, 6, 8) for each smear. Views 1 and 2 were for practice. A counterbalanced design was employed to control effects of fatigue. The observers practiced scaling OPACITY and EXTRUDABILITY on views 1 and 2, and then were tested with views 4 and 5. They then practiced scaling EXPLOSIVENESS and LOOSENESS on views 1 and 2 and were tested with views 4, 5, 6 and 8. They then were retested on OPACITY and EXTRUDABILITY, scaling views 6 and 8. Discarding the practice sequences, each observer made a total of four assessments on each smear for each dimension.

c. Instructions. In addition to the same general instruction provided in Study III, the observers were given the following brief definitions of the dimensions while the experimenter pointed to relevant features in sample views of the imagery:

(1) OPACITY is a quality of see-throughness. Water is transparent. If a material is opaque you can't see any light through it.

(2) EXTRUDABILITY is a quality that makes a material deform and flow when it is squeezed. Think of the cells as about as big as your hand. How would they feel if you picked them up and squeezed them. Would they extrude like a pancake, or would they crumple up like Saran® wrap?

(3) To assess EXPLOSIVENESS, think of the way the material was laid down. Were the cells shot explosively into their locations, or were they

gently wafted into place?

(4) STICKINESS is a quality that makes a material cling to itself. Think of Saran® wrap. It clings to itself. Cellophane stays loose. Think of the cells as about as big as your hand. Think of picking up some that are lying together. Would they cling to each other? How would it feel to pull them apart?

The scaling format, shown in Table VI, was also different from that used in Study III with anchor points of familiar materials added to two of the dimensions.

TABLE VI

FORMAT FOR SCALING TEXTURES (STUDY IV)

1	Transparent	0	1	2	3	4	5	6	7	8	9	Opaque	1
2	Pliable	0	1	2	3	4	5	6	7	8	9	Extrudable	2
		Saran® Wrap									Molding Clay		
3	Calm	0	1	2	3	4	5	6	7	8	9	Explosive	3
4	Sticky	0	1	2	3	4	5	6	7	8	9	Loose	4
		Saran® Wrap									Cellophane		

d. Results. The mean scale value for each smear, averaged over all views and all observers, is shown in Table VII.

Evidence of Reliability. Inspection of the data in Table VII reveals a degree of inhomogeneity, both within and between dimensions, which suggests that the observers are assigning scale values nonrandomly and with some degree of consistency from observer to observer. We refer to the discussion in the results of Study III for an outline of the logic behind that inference. We again seek indirect but objective evidence of consistency in correlations between dimensions. A matrix of Spearman Rank Order Correlations is presented in Table VIII, which shows significant correlations in all cases.

Beyond that general interpretation, we can also point out that there is a greater proportion of pairs of dimensions in this study than in Study III that are significantly correlated. This could be because the variations along the two new dimensions tested here are more discriminable. It could also be due to the fact that the assessments are more precise here, due to two factors: (1) The observers based their judgments on four views of each smear here, whereas in Study III they based their judgments on only three views, and (2) There were nearly three times as many observers participating. These factors both add up to each assessment being based on nearly four times as

TABLE VII

MEAN SUBJECTIVE SCALE VALUES (STUDY IV)

Slide #	OPACITY	EXTRUDABILITY	EXPLOSIVENESS	LOOSENESS
		Positive Smears		
2	5.22	4.93	5.04	5.40
9	4.31	4.73	4.60	5.06
12	4.32	4.97	4.76	5.25
15	3.88	4.56	3.78	5.59
18	5.93	5.28	5.01	3.37
19	4.87	4.96	4.38	5.05
24	5.64	5.10	5.50	4.17
26	5.12	5.23	5.36	4.38
38	5.18	5.22	5.53	4.47
45	5.84	5.22	6.32	3.19
		Negative Smears		
3	5.20	5.09	5.14	4.18
4	4.62	4.96	4.81	4.27
5	4.63	4.95	4.97	4.94
7	5.64	5.25	6.18	3.25
10	4.63	4.91	4.97	4.80
11	5.44	4.97	5.45	4.06
13	5.29	5.11	5.61	4.37
14	4.99	4.90	4.88	4.62
16	5.28	5.12	5.63	3.92
20	5.61	5.33	5.87	3.63

TABLE VIII

SPEARMAN RANK ORDER CORRELATIONS BETWEEN DIMENSIONS (STUDY IV)
(Correlations for positive smears lie above the diagonal;
those for negative smears lie below)

	OPACITY	EXTRUDABILITY	EXPLOSIVENESS	LOOSENESS
OPACITY	--	.74*	.74*	-.78**
EXTRUDABILITY	.79**	--	.66*	-.83**
EXPLOSIVENESS	.92***	.90***	--	-.69*
LOOSENESS	-.78**	-.85**	-.82**	--

*Significant at $p < .05$ two-tailed

**Significant at $p < .01$ two-tailed

***Significant at $p < .001$ two-tailed

many individual assessments (280 to 72). We also have to consider that the observers here were provided with rudimentary perceptual operations, and anchor points on two of the scales. Each of these factors could also have contributed toward increasing precision of the subjective estimates. But to determine whether the overall record of reliability is better here than in Study III because of greater discriminability along the dimensions or more precise assessments would require further study.

Evidence of Validity. We again sought evidence of validity, first through Mann-Whitney U Tests which revealed no statistically significant difference between positive and negative smears on any of the four dimensions.

The next step in testing validity was to plot the data in all possible 2-spaces. We then inspected these plots for evidence of separation in the manner described previously in the general method section. Three of the six possible pairings gave evidence of separation and are shown in Figure 6. In each case inspection reveals that a straight line, drawn through the space, can partition most of the negative from most of the positive smears. The implications for these separation schemes, if they were to prove reliable, have already been discussed for similar results in Study III.

Evidence of Effects of Instructions and Anchor Points. We look first at the effects of a variation in instructions. In Study III, the observers were

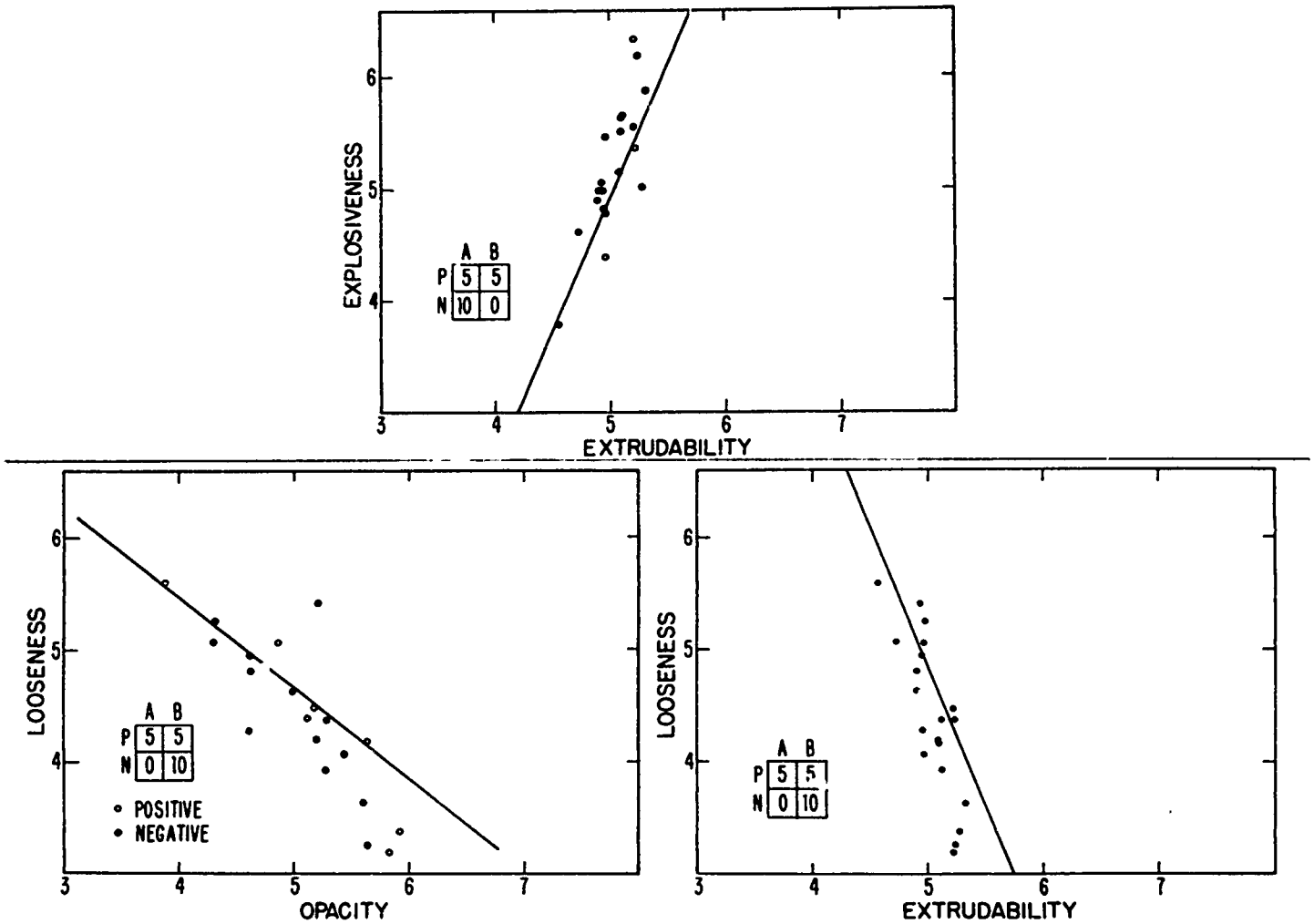

Figure 6. Potentially Useful Decision Boundaries for Identifying Suspicious Smears in Prescreening. The straight line drawn through each space partitions most of the positive from most of the negative smears. The number of positive and negative smears falling above or below the decision boundary are shown in a 2x2 table. (Study IV)

left to define and evaluate EXPLOSIVENESS in their own individual ways. In this study they were given a definition which provided them with a standard way of visualizing EXPLOSIVENESS. The effect of this variation in instructions is tested by a Wilcoxon matched pairs signed ranks test (Siegel, 1956, pp. 75-83). In that test, the mean scale values of EXPLOSIVENESS for each of the negative smears obtained in Study III were paired with those obtained in this study. The same test was made on the positive smears. There was no statistically significant difference between assessments of the positive smears, but assessments of the negative smears were significantly effected ($T = 5$, $p < .02$, two-tailed). The same smears tended to get higher assessments of EXPLOSIVENESS in this study than they did in Study III. The most likely cause of this effect is the change in instructions. However, different observer populations were involved, which might also account in whole or in part for the effect. Whatever the case, this result demonstrates how sensitive these assessments can be to task or observer variables. This could either indicate unreliability or suggest the positive quality that these assessments can be shaped by means of observer selection, instruction and training.

In an examination of the combined effects of a difference in instructions and a difference in anchor points, the observers were given: (1) a definition of LOOSENESS, (2) a rudimentary perceptual operation for assessing it, and (3) anchor points on the 10 point scale. We looked for statistically significant effects, again using a Wilcoxon matched pairs signed ranks test. No statistically significant difference was found for the positive smears, but assessments of the negative smears were significantly affected ($T = 7$ $p < .05$, two-tailed). The same smears tended to get higher ratings of LOOSENESS in this study than they did in Study III with the most likely causes of this effect the changes in instructions and scaling format. But, again, this interpretation has to be tempered by consideration of differences in the observer populations.

4. STUDY V. A PSYCHOMETRIC EVALUATION OF FOUR DIMENSIONS OF TEXTURE ASSESSMENT MADE BY CYTOTECHNICIANS BEFORE AND AFTER TRAINING.

The observers in this study were student cytotechnicians. We had an opportunity to study their performance both before and after training. In each test they performed the same task as in Study IV, except that they saw two more views of each smear. This study examines the performance of a small group of highly motivated observers and the effects of training on their performance.

a. Observers. There were 10 observers, students in the Boston School of Cytotechnology who participated in the study voluntarily as part of their training.

b. Method. Views 1, 2, 3, 4, 5, 6, 7 and 8 were used as the stimuli. Views 1 and 2 from each of the 20 smears were used for practice. Other than the addition of Views 3 and 7 to the test series, the procedure was the same as in Study IV. Test 1 was administered on the first day that the students attended classes at the Boston School of Cytotechnology with Test 2 administered approximately six months later, after the students had largely completed their classroom studies and were training on-the-job in cytology laboratories at several hospitals in the Boston area.

c. Results of Test 1. The mean scale value for each smear, averaged over all views and all observers, is shown in Table IX.

(1) Evidence of Reliability. The data in Table IX reveal, as they did in the previous studies, a degree of inhomogeneity that indicates the observers were not responding randomly, and which provides evidence of a certain degree of inter-observer consistency. Objective, but still indirect evidence of reliability is presented in Table X, which shows Spearman Rank Order Correlations between dimensions.

Statistically significant correlations occur in eight cases. A comparison of the correlation matrix obtained here in Study V, Test 1 with that in Study IV reveals a greater proportion of statistically significant correlations in Study IV, probably because each assessment here is based on only 60 observations in contrast to 280 in Study IV. Therefore it appears that there are detectable effects on the reliability of performance due to changing the number of observations, at least four-fold. It is important to note also that this effect was probably attenuated by two factors: (1) the observers in Study V, Test 1 saw two more views of each smear than the observers in Study IV and (2) the observers in Study V, Test 1 had some vested interest in what they were doing and were probably highly motivated.

Direct evidence of reliability is available in correlations between the mean scale values obtained in this study and those obtained in Study IV. Spearman Rank Order Correlations were computed for positive and negative smears separately and are shown in Table XI.

(2) Evidence of Validity. Mann-Whitney U Tests revealed no statistically significant differences between distributions of the mean scale values for positive and negative smears. The data were next plotted in all possible 2-spaces, and evidence was sought, in the plots, of separation of positive and negative smears. Following the procedure outlined in the General Method section herein, five spaces were found in which separation occurred as shown in Figure 7.

d. Results of Test 2 (After Six Months Training). The mean scale values for each smear, averaged over all views and all observers, are presented in Table XII.

Evidence of Reliability. The same observations can be made regarding inhomogeneities between and within dimensions that were made in previous discussions. They imply a certain degree of consistency over observers. We turn again to correlations between dimensions for objective evidence of consistency with Spearman Rank Order Correlations between all possible pairs of dimensions shown in Table XIII. In all but one case, the correlations are statistically significant.

It is also possible to obtain direct evidence of reliability by correlating the mean scale values obtained here, with those obtained in Test 1. The indices of reliability are shown in Table XIV. In a pure sense the assessments made in the two studies are not independent and the legitimacy of the measure of reliability could be questioned. For all practical purposes, however, they probably are independent, since it is very unlikely that observers, in taking

TABLE IX

MEAN SUBJECTIVE SCALE VALUES (STUDY V, Test 1)

Slide #	OPACITY	EXTRUDABILITY	EXPLOSIVENESS	LOOSENESS
		Positive Smears		
2	5.93	5.58	5.85	3.27
9	3.70	4.75	4.93	5.27
12	3.83	4.83	5.83	4.35
15	3.25	4.40	4.52	6.23
18	4.82	5.37	5.87	2.67
19	4.23	5.05	5.32	5.03
24	4.05	5.02	5.98	3.42
26	4.33	5.60	6.55	3.08
38	4.70	5.17	5.78	3.68
45	5.45	5.57	5.43	3.73
		Negative Smears		
3	5.13	5.33	5.15	4.13
4	4.57	4.17	4.87	4.35
5	3.10	4.08	3.90	6.25
7	3.53	4.85	5.88	4.08
10	4.48	4.53	4.00	5.38
11	5.65	5.50	5.82	2.52
13	5.05	5.28	4.75	4.55
14	3.85	4.52	4.67	5.07
16	6.40	6.18	5.30	2.07
20	4.30	4.66	6.00	3.12

TABLE X

SPEARMAN RANK ORDER CORRELATIONS BETWEEN DIMENSIONS (STUDY V, Test 1)
(Correlations for positive smears lie above the diagonal;
those for negative smears lie below.)

	OPACITY	EXTRUDABILITY	EXPLOSIVENESS	LOOSENESS
OPACITY	--	.88***	.44	-.71*
EXTRUDABILITY	.79**	--	.64*	-.79**
EXPLOSIVENESS	.29	.58	--	-.90***
LOOSENESS	-.53	-.78**	-.89***	--

*Significant at $p < .05$, two-tailed
**Significant at $p < .01$, two-tailed
***Significant at $p < .001$, two-tailed

TABLE XI

RELIABILITY OF MEAN SCALE READINGS BETWEEN STUDY IV AND STUDY V, Test 1.
(Spearman Rank Order Correlations)

	Positive Smears	Negative Smears
OPACITY	.81***	.10
EXTRUDABILITY	.65*	.56*
EXPLOSIVENESS	.53	.75**
LOOSENESS	.54	.90***

*Significant at $p < .05$, one-tailed
**Significant at $p < .01$, one-tailed
***Significant at $p < .001$, one-tailed

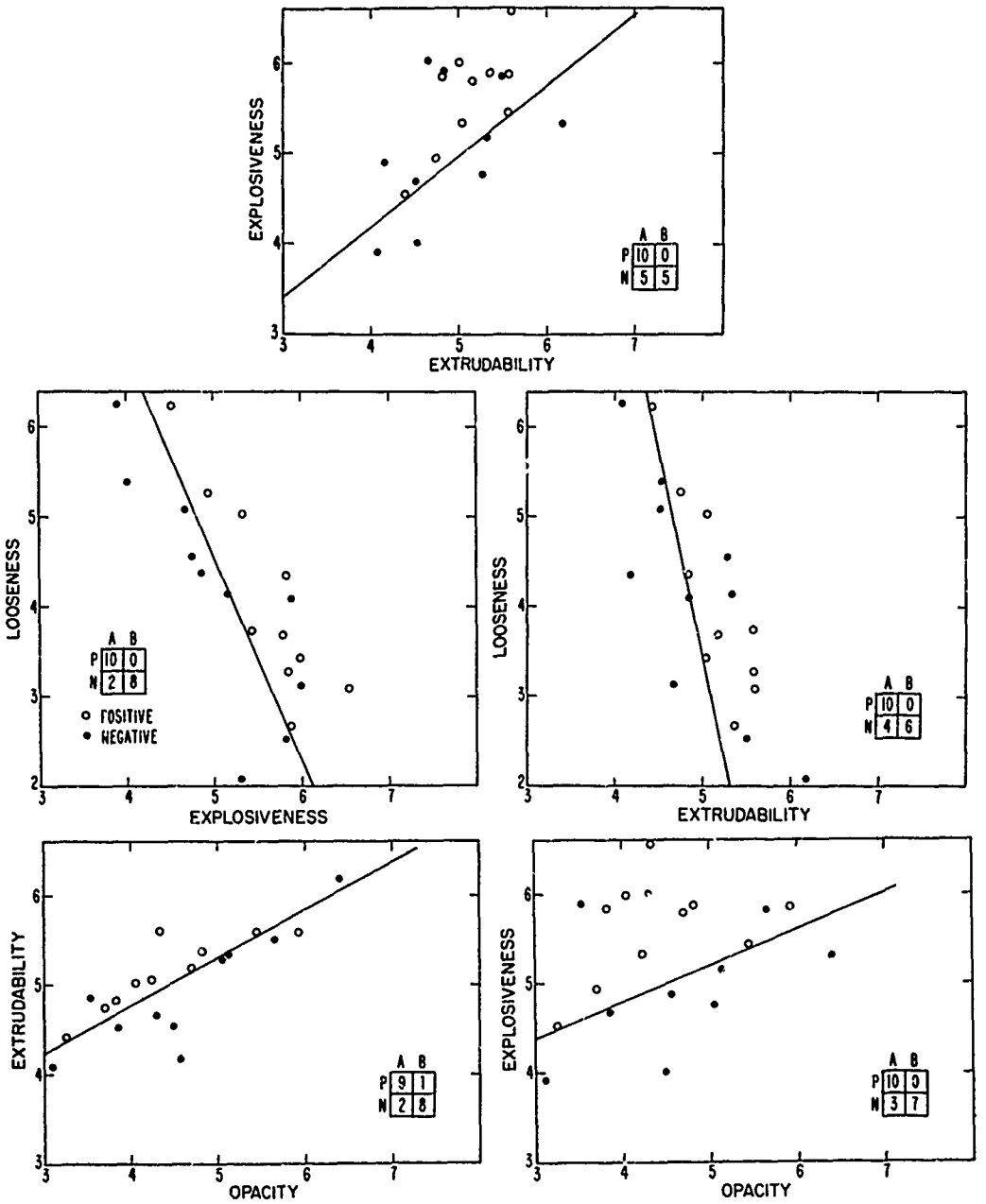

Figure 7. Potentially Useful Decision Boundaries for Identifying Suspicious Smears in Prescreening. The straight line drawn through each space partitions most of the positive from most of the negative smears. The number of positive and negative smears falling above or below the decision boundary are shown in a 2x2 table. (Study V, Test 1)

TABLE XII

MEAN SUBJECTIVE SCALE VALUES (STUDY V, Test 2)

Slide #	OPACITY	EXTRUDABILITY	EXPLOSIVENESS	LOOSENESS
		Positive Smears		
2	7.33	7.52	6.72	2.73
9	5.67	6.28	5.02	4.23
12	4.63	5.47	5.17	4.67
15	3.47	4.55	3.75	5.92
18	5.63	6.65	6.17	2.57
19	4.28	5.53	4.80	4.77
24	4.57	5.67	5.98	3.72
26	5.68	6.58	6.30	3.28
38	6.72	7.02	6.28	3.05
45	6.78	6.88	6.06	3.61
		Negative Smears		
3	6.27	6.55	5.30	4.12
4	4.32	4.40	4.74	5.27
5	4.38	5.02	3.80	5.22
7	3.46	4.62	5.35	5.07
10	3.90	3.85	3.45	6.07
11	5.60	5.90	5.80	3.47
13	4.93	5.48	4.78	5.17
14	3.50	3.72	4.08	5.83
16	7.00	7.00	5.70	2.70
20	4.17	4.93	5.47	4.65

TABLE XIII

SPEARMAN RANK ORDER CORRELATIONS BETWEEN DIMENSIONS (STUDY V, Test 2)
(Correlations for positive smears lie above the diagonal;
those for negative smears lie below.)

	OPACITY	EXTRUDABILITY	EXPLOSIVENESS	LOOSENESS
OPACITY		.92***	.82**	-.73*
EXTRUDABILITY	.91***		.86**	-.88***
EXPLOSIVENESS	.45	.65*		-.90***
LOOSENESS	-.68*	-.88***	-.92***	

*Significant at $p < .05$, two-tailed
**Significant at $p < .01$, two-tailed
***Significant at $p < .001$, two-tailed

TABLE XIV

RELIABILITY OF MEAN SCALE READINGS BETWEEN STUDY V, TEST 1 AND
STUDY V, TEST 2
(Spearman Rank Order Correlations)

	Positive Smears	Negative Smears
OPACITY	.78**	.80**
EXTRUDABILITY	.76**	.76**
EXPLOSIVENESS	.73*	.88***
LOOSENESS	.88***	.89***

*Significant at $p < .05$, one-tailed
**Significant at $p < .01$, one-tailed
***Significant at $p < .001$, one-tailed

Test 2, could remember what the smears looked like and how they assessed them in Test 1. Note, in comparing these indices with those in Table XI, that we are correlating assessments made by the same observers in Table XIV and different observers in Table XI.

Evidence of Validity. Mann-Whitney U tests were performed to determine whether there were any statistically significant differences in mean scale values between positive and negative smears. They revealed a difference in only one case where assessments of EXTRUDABILITY on positive smears are higher than on negative smears ($p < .05$, two-tailed). This variable suggests itself, therefore, as a valid discriminator of positive and negative smears.

We next sought evidence of separation in plots of the data in all possible 2-spaces. Evidence of separation was found in four cases shown in Figure 8.

Evidence of the Effects of Training. Two effects of training are evident from Wilcoxon tests of difference in distribution between the mean scale values in Test 1 and Test 2, which reveal differences in positive smears on two dimensions. After training, the same smears receive lower assessments of OPACITY and EXTRUDABILITY ($p < .001$, two-tailed, in both cases). Another effect of training is suggested in a comparison of the correlation matrix in Table XIII with that in Table X. There is a greater number of statistically significant correlations between dimensions in Study V, Test 2 than in Study V, Test 1 and in every case but one (in which there is a tie) the correlation indices are higher in Study V, Test 2 than in Study V, Test 1, suggesting that training tends to increase reliability of the assessments.

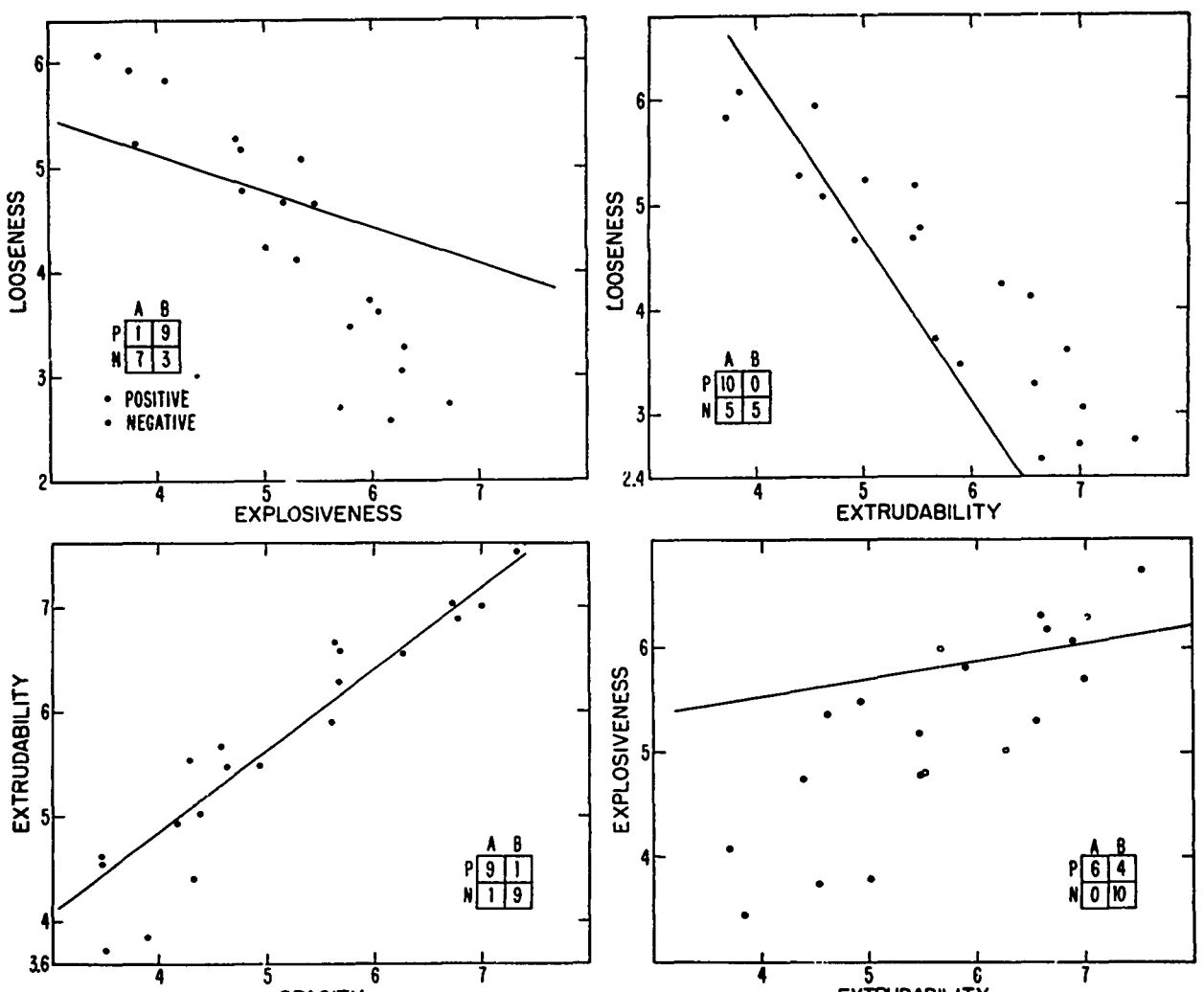

Figure 8. Potentially Useful Decision Boundaries for Identifying Suspicious Smears in Prescreening. The straight line drawn through each space partitions most of the positive from most of the negative smears. The number of positive and negative smears falling above or below the decision boundary are shown in a 2x2 table. (Study V, Test 2)

SECTION IV
SUMMARY OF RESULTS AND DISCUSSION

The most firmly established and general finding is that observers can reliably discriminate and scale variations in several qualities of the total appearance of smears seen at low microscopic power. Evidence of reliability has been presented in each study in the form of a matrix of correlations between dimensions and we give, in Table XV, a summary of the significant correlations that were found in each of those matrices. It shows that there were eight pairs of dimensions that correlated significantly in one or another study,

TABLE XV

SUMMARY OF SIGNIFICANT CORRELATIONS BETWEEN DIMENSIONS FOUND IN EACH STUDY

		Positive Smears				Negative Smears			
		III	IV	V(1)	V(2)	III	IV	V(1)	V(2)
EXPLOSIVENESS	X DIRTINESS	o	.	.	.	+	.	.	.
	X DOUGHINESS	+	.	.	.	o	.	.	.
	X LOOSENESS	-	-	-	-	-	-	-	-
	X OPACITY	.	+	o	+	.	+	o	o
	X EXTRUDABILITY	.	+	+	+	.	+	+	+
EXTRUDABILITY	X LOOSENESS	.	-	-	-	.	-	-	-
	X OPACITY	.	+	+	+	.	+	+	+
LOOSENESS	X OPACITY	.	-	-	-	.	-	o	-

+ = positive correlation
- = negative correlation
o = no significant correlation
. = no test

in either the positive or the negative smears. Two of those cases (EXPLOSIVENESS X DIRTINESS and EXPLOSIVENESS X DOUGHINESS) were only tested once, in Study III, and in each case the correlations did not occur in both the positive and the negative smears. The evidence of reliability of judging DIRTINESS and DOUGHINESS is, therefore, marginal. In the other six cases there were multiple tests, and the same direction of correlation was repeatedly found in both the positive and the negative smears. These six cases were made up of combinations of four dimensions: EXPLOSIVENESS, LOOSENESS, EXTRUDABILITY and OPACITY. We conclude that variations along those four dimensions definitely

are correlated, and that observers can reliably see and scale variations along each of those dimensions. The evidence of correlations within dimensions presented in Tables XI and XIV provide additional and consistent evidence of reliability. We can see an obvious similarity of assessment across the three groups of observers, and that permits the generalization that similar assessments would be made by other similarly constituted groups of observers. We can also see similar patterns of correlations in two independent groups of smears, the 10 positive and the 10 negative, which provide a slim but clear basis for generalizing this result to all smears.

Evidence of validity was sought in each study; first with Mann-Whitney U tests of difference between positive and negative smears on individual dimensions, and second with tests of separation in 2-space. In only one of the Mann-Whitney U tests performed over the three studies was a statistically significant difference found between positive and negative smears. That difference, positive higher than negative on the EXTRUDABILITY dimension was found in Study V, part 2. In view of its probability ($p < .05$) and the total number of tests performed (18), that difference could reasonably be attributed to chance.

A summary of the tests of separation in 2-space is presented in Table XVI, with each separation coded for the form it assumed. In general, the decision boundary is drawn through the long axis of the scatter plot, and within each 2-space, then, it has roughly the same orientation from one experiment to the next, but the proportion of positives and negatives which fall above and below the line can vary. Each separation can be characterized as having the majority of positive smears above or negative smears below the decision boundary (coded 1), or vice versa (coded 2) (see Table XVI).

There were eight spaces in which separation occurred, and six of those spaces were subjected to repeated tests. To establish whether these separations might reasonably have occurred by chance, we considered first that if positive and negative smears were randomly mixed in the scatter plots, then separations of the kind we have defined would be expected to occur less often than not. We have, therefore, selected .5 as a conservative upper bound on the chance probability of separation. We also considered that if separations were a matter of chance, when they did occur they would assume one or the other form with equal probability. Our statistical analyses are based, therefore, on the following chance probabilities for the outcome of each experiment:

no separation, (0),	$p(0) = .5$
separation of form 1, (1)	$p(1) = .25$
separation of form 2, (2),	$p(2) = .25$

Based on these probabilities, separation in any individual experiment would not be significant ($p < .5$, two-tailed), but evidence of repeated separation could be significant. We proceeded therefore to determine the probability of each set of results obtained in the repeated tests. Table XVI shows, for example, that separation was found in the LOOSENESS X EXPLOSIVENESS space in three out of four experiments. There were two separations of form 1 and one of form 2. We calculated the chance probability of obtaining a sequence with

at least that number of separations and with at least that proportion of more or less frequent form (consistency of separation). This was achieved by determining the combined probability of the following sets of possible results, in any order: 1111, 1112, 1110, 1120

$$p\ (1111) = .25^4 \times 1 = .0039$$

$$p\ (1112) = .25^4 \times 4 = .0156$$

$$p\ (1110) = .25^3 \times .50 \times 4 = .0312$$

$$p\ (1120) = .25^3 \times .50 \times 12 = .0937$$

$$.1444$$

The two-tailed probability is then determined by doubling that combined probability. Thus, for a set of results with at least the number and consistency of separations found for the LOOSENESS X EXPLOSIVENESS space, the probability of chance occurrence is $p < .29$. This same method of calculation was applied to each set shown in Table XVI, and the associated probabilities are shown at the right.

We can conclude from the analysis that there is at least one space, LOOSENESS X EXTRUDABILITY, in which positive smears probably do separate from negative smears. The evidence in sum, though based on a very crude test of separation, warrants the conclusion that subjective assessments of the overall appearance can separate positive from negative smears in our small test sample. We have to be cautious, however, in generalizing that conclusion to all smears A confident generalization would have to depend on evidence from studies employing a much larger sample of smears. The important point, however, is that observers can reliably sense and scale variations in the overall appearance of smears, and if some of those variations do relate to the presence or absence of cancer, it is simply a matter of more extensive studies of the kind reported here to identify them.

With regard to other findings from these studies, comparisons between experiments were also made to check on various effects of instructions, scaling format and training. Several findings are presented in the results sections of Experiments IV, V, Test 1 and V, Test 2. Statistically significant differences in performance between Experiments III and IV were found that were probably due to differences in instructions and scaling format. A drop in reliability between Study IV and Study V, Test 1 was interpreted as caused by a four-fold decrease in the number of assessments per smear. Greater reliability in Study V, Test 2 over Study V, Test 1, also other differences in scaling, were attributed to the effects of training.

We consider now implications of these findings for the specific problem of interpreting and screening Pap smears. Psychometric assessments of the kind we report here may help in providing more sensitive and quantitative assessments of background variations which have to be taken into account in interpreting cellular changes, perhaps also in contributing directly to the diagnosis of cancer. These techniques might also be used to generate sets of quantified visual standards of background variation systematically related to such

TABLE XVI

SUMMARY OF SEPARATIONS IN 2-SPACE FOUND IN EACH STUDY

2-Space	STUDY III	IV	V 1	V 2			
DULLNESS X DIRTINESS	2	_	_	_	$p < .50$	two-tailed*	
DIRTINESS X LOOSENESS	1	_	_	_	$p < .50$	"	"
LOOSENESS X EXPLOSIVENESS	1	0	1	2	$p < .29$	"	"
LOOSENESS X OPACITY	_	1	0	0	$p < .63$	"	"
LOOSENESS X EXTRUDABILITY	_	1	1	1	$p < .04$	"	"
EXTRUDABILITY X EXPLOSIVENESS	_	2	1	1	$p < .13$	"	"
EXTRUDABILITY X OPACITY	_	0	1	1	$p < .25$	"	"
EXPLOSIVENESS X OPACITY	_	0	1	0	$p < .63$	"	"

_ = no test

0 = no separation (see text p. 17 for criteria)

1 = separation with majority of positives above or negatives below the decision boundary.

2 = separation with majority of negatives above or positives below the decision boundary.

* The two-tailed probability of obtaining a sequence with at least that number of separations and at least that proportion of more to less frequent form of separation (see text for further explanation).

variables as age, menstrual cycle, and acute infection as well as to the course of chronic diseases, which might prove helpful particularly in training cytotechnicians.

We can also consider the possible value of psychometric assessments in cytological research. Identifying variations in background qualities and in determining correlations among those variations may contribute to cytological or histological theory. Finally, we can suggest the potential role of psychometric assessments in discovering disease related optical properties in the background, subject to automated analysis. Automated analysis of background qualities might prove to be more easily achieved than automated analysis of cellular characteristics.

Our findings are also significant from a general standpoint. They show that human assessments of complex optical imagery can be discriminating, quantitative and reliable. They suggest that there may be much more information available in subjective assessments of imagery than is usually assumed. Those investigators concerned with imagery analysis are quick to acknowledge that the human observer is a most elegant pattern recognizer, but, at the same time, many would be quick to consider abandoning him for the most primitive automatic optical analyzer. There is an understandable scientific prejudice that human assessments are unreliable and insensitive, which may be true to a degree for observers who operate individually according to their own idiosyncratic procedures and internal standards. These studies illustrate, however, that observers can be programmed to follow standard perceptual operations and gauge their judgments against common standards. By pooling and averaging repeated independent assessments, we can generate sensitive and reliable data. The central question may not be whether human assessments can be sufficiently sensitive and reliable for scientific purposes, but whether we can tolerate the potentially cumbersome and costly procedures that may be required to achieve sensitivity and reliability: namely, the coordinating and pooling of assessments from a number of observers. These studies, however, show that the approach may be practical. In Study V, for example, remarkably reliable and sensitive discrimination was achieved by pooling the assessments of only 10 observers. Furthermore, each assessment on each smear took less than seven man minutes, and considering the potential for increasing the rate of display presentation and response recording by automated techniques, that time could probably be halved. These techniques, therefore, could be of value, not only in research, but in routine screening situations as well.

The studies reported in Section III lead to the conclusion that subjective assessments of texture may be of practical use in the analysis and screening of Pap smears. With similar studies of texture assessments in solar observing reported elsewhere (Pickett, 1971), they support the general conclusion that psychometric techniques may be of practical use in a wide range of imagery screening contexts. Of particular significance to the Air Force is the possibility of using subjective texture assessments in intelligence screening of aerial photographs.

APPENDIX I
CHECKLIST USED TO SURVEY DESCRIPTORS OF TEXTURE IN 100X VIEWS OF PAP SMEARS

Name:_____

Laboratory:_____

Instructions:

(1) write name and laboratory on pp. 1 & 2;
(2) Place a check mark in only one of the columns for each word;
(3) Be sure to check every word;
(4) Add and classify at bottom of p. 2 any other descriptive adjectives that come to mind;
(5) Please work independently.

	Describes a visible quality which:			Does not describe a visible quality
	suggests negative	makes you suspicious	suggests positive	
Bright				
Brittle				
Calm				
Clean				
Clumped				
Cohesive				
Compact				
Consistent				
Creamy				
Crumbly				
Dirty				
Doughy				
Droopy				
Dull				
Elastic				
Enmeshed				
Explosive				
Extrudable				
Fatty				
Fibrous				
Filmy				
Firm				
Floating				
Fragile				
Gluey				
Granular				
Gummy				
Hard				
Leathery				
Loose				
Lumpy				
Lustrous				

Name:_____ Laboratory_____

	Describes a visible quality which:			Does not describe a visible quality
	suggests negative	makes you suspicious	suggests positive	
Matted				
Milky				
Oily				
Opaque				
Pasty				
Pearly				
Pliable				
Puffy				
Pulpy				
Raw				
Regular				
Ropy				
Rubbery				
Shrunken				
Shiny				
Silky				
Slimy				
Slippery				
Soapy				
Soft				
Spongy				
Starchy				
Sticky				
Stiff				
Thick				
Tight				
Transparent				
Variable				
Velvety				
Waxy				

APPENDIX II
A THESAURUS OF DESCRIPTORS OF COMPLEX OPTICAL IMAGERY

1. GENERAL DESCRIPTION AND SUGGESTED APPLICATIONS.

Presented below is a word list of potential use in surveying and enhancing the descriptive vocabulary of workers who screen complex optical imagery. The list consists of 1707 entries (1058 different words) organized under 177 subheadings and 130 major headings keyed to Roget's Thesaurus (The Original Roget's Thesaurus of English Words and Phrases, St. Martins Press, New York, 1965). It provides a comprehensive list that should be helpful in assembling checklists for surveys of specialized visual description such as those reported in Section II. The researcher can feel confident that in scanning this list he has been reminded of a very broad range of potential visual description without having to carry out a systematic survey of a standard dictionary or thesaurus.

The list is presented in two forms: one with the 1058 base words presented in alphabetical order; the other with the 177 subheadings presented in alphabetical order. With the first form, one or two descriptors which may come to mind in scanning samples of complex imagery can be looked up to determine the subheadings under which they occur in the second form. By examining the word families listed under those subheadings, the viewer may then discover descriptors which more sharply capture the sensed visual qualities than the words that first came to mind. Scrutiny of the word families may also reveal gradations of meaning that suggest a basis for scaling the imagery along qualitative dimensions; and inter-family comparisons may suggest frameworks for multidimensional scaling.

2. SPECIFIC DESCRIPTION AND METHOD OF PREPARATION.

This specialized thesaurus was prepared because it became obvious at the start of the work reported in Section I that a systematic approach to selection of words for the checklist was required. The problem was to assure that the checklist was efficient in the sense of including mostly relevant descriptors, and comprehensive in not leaving many out. Our first effort was an attempt to assemble a master list of all adjectives of visual description from which one could abstract most of the potentially relevant descriptors for any particular problem of visual description that came along. The criteria for including a word in that master list were that it describe any directly visible quality of an object or batch of material, e.g., mottled or marbled; or any quality of a substantive or structural nature which might be inferred from its appearance, e.g., flexible from its wrinkled or droopy appearance, or brittle from its fragmented appearance. Beginning with a list of all adjectives we could recall that fit the criteria, we continued with a systematic scan of relevant sections of Roget's Thesaurus for all words we could recognize that fit the criteria. At this stage it became apparent that the task was unmanageable, first, for the sheer number of words that had to be examined in the obviously relevant broad categories in Roget's Thesaurus, and second, because there was no logical basis for identifying all of the less obviously relevant narrow categories which we kept discovering. At this point we stopped the process to devise a more manageable approach.

In our revised approach, we searched in two stages, using two thesauruses. In the first stage, we scanned March's Thesaurus (March's Thesaurus and Dictionary of the English Language, Doubleday, New York, 1968), to make a fine-grained identification of all relevant categories. In the second stage, we returned to Roget's Thesaurus, this time equipped with a manageable but comprehensive scheme. March's Thesaurus is suited to a systematic screening for all relevant categories because it is not hierarchically organized. It is basically a dictionary, but at frequent intervals in the alphabetic listing it treats a word as a reference word, organizing under it, as in Roget's Thesaurus, a family of related words. Because of this non-hierarchical arrangement, March's Thesaurus permits making a systematic scan. One can go through it from A to Z, looking not at every word, but at least at every reference word. Under every reference word is a small clearly segregated list of related adjectives, so that, at a glance, one can tell whether words in that narrow category fit the criteria for visual descriptors.

Our systematic scan of March's Thesaurus yielded 146 narrow categories of visual description (See Table XVII). At this point we listed all the adjectives in March's Thesaurus found under those categories that fitted our criteria. We then combined that list with the partial list we had already assembled by the first procedure. That combined interim list was then subjected to some editing. We decided to focus primarily on descriptors of masses of visible material as opposed to descriptors of particular objects or specific visual patterns; to exclude, e.g., specific descriptors like square, circular and octagonal, and to retain general descriptors, e.g., angular, curly, and bumpy. Some specific descriptors may still appear in the list, but generally we sought adjectives for mass nouns. We also decided to exclude most of the words for colors, and words for describing dynamic qualities, e.g., churning, scintillating. When edited, the combined interim list totaled 514 words.

In the next stage, we looked up in Roget's Thesaurus each of the 514 words in the interim list, and scanned the paragraphs of adjectives in which they occurred, looking for other adjectives that fit our criteria. The original look-up word from the interim list (identified by an asterisk) plus any other words we found in that paragraph were then entered in column 1 of the master list. The initial italicized word in the paragraph in which each entry was found serves as that entry's subheading, and is listed across from it in column 2. The number of the heading under which the paragraph appears serves as the major heading for each entry and is listed across from it in column 3.

TABLE XVII
LIST OF VISUALLY RELEVANT REFERENCE WORDS
FROM MARCH'S THESAURUS

ACTION-PASSIVENESS
ACTIVITY-INDOLENCE
ADDITION-SUBTRACTION
ADMISSION-EXCLUSION
ADMISSION-EXPULSION
ADVANCE-RETROGRESSION
AGITATION
ANGULARITY
AIM-ABERRATION
ANTERIORITY-POSTERITY
APERTURE-CLOSURE
ARCHITECTURE
ATTRACTION-REPULSION
BEAUTY-UGLINESS
BETTERMENT-DETERIORATION
BLUENESS-ORANGE
BORDER
BOUNDARY
BREADTH-NARROWNESS
CACOPHONY
CIRCLE-WINDING
CIRCUITION
CLEANLINESS-FILTHINESS
CLEARNESS-OBSCURITY
COHESION-LOOSENESS
COLOR-ACHROMATISM
COMPOSITION-RESOLUTION
CONCENTRATION-RADIATION
CONFINEMENT
CONNECTION-INDEPENDENCE
CONTENTS-RECEIVER
CONTINUITY-INTERRUPTION
CONVEXITY-CONCAVITY
COVER-LINING
CRASH-DRUMMING
CROSSING
CURVATION-RECTILINEARITY
DAMPNESS-DRYNESS
DIAPHANEITY-OPALESCENCE
DIAPHANEITY-OPAQUENESS
DIMNESS
DRESS-UNDRESS
ELASTICITY-INELASTICITY
ELEVATION-DEPRESSION
EMBELLISHMENT-DISFIGUREMENT
ENLARGEMENT-DIMINUTION
ENTIRETY-DEFICIENCY
ERECTNESS-FLATNESS
EXCESS-LACK
EXCITABILITY-INEXCITABILITY
EXCITATION
FAULTLESSNESS-FAULTINESS
FEELING-INSENSIBILITY
FORM-FORMLESSNESS
FRIABILITY
FRICTION-LUBRICATION
GATHERING-SCATTERING
GRAY-BROWN
GREATNESS-LITTLENESS
GROOVE
HARDNESS-SOFTNESS
HARSHNESS-MILDNESS
HEAVINESS-LIGHTNESS
HURRY-LEISURE
IMPETUS-REACTION
INCLUSION-OMISSION
INCREASE-DECREASE
INCREMENT-REMNANT
INDENTATION
INFANCY-AGE
INJECTION-EJECTION
INSTRUMENT
INSTRUMENTALITY
INTERSPACE-CONTACT
KEEPING-RELINQUISHMENT
LAMINA-FIBER
LASTING-TRANSIENTNESS
LATERALITY-CONTRAPOSITION
LEADING-FOLLOWING
LENGTH-SHORTNESS
LEVELNESS
LIGHT-DARKNESS
LIQUEFACTION-VOLATILIZATION
LIQUID-GAS
LUMINARY-SHADE
MAGNITUDE-SMALLNESS
MANIFESTATION-LATENCY
MIDDLE
MINERALOGY
MIXTURE-HOMOGENEITY
MOVEMENT-REST
MULTIPLICITY-PAUCITY
MUTABILITY-STABILITY
MUTATION-PERMANENCE
NEED
NUMBER

NUMBERING
OBSTRUCTION-HELP
ORGANIZATION-DISORGANIZATION
OUTLINE
OUTSIDE-INSIDE
PARALLELISM-INCLINATION
PERIODICITY-IRREGULARITY
PLICATURE
PRECEDENCE-SUCCESSION
PREPARATION-NONPREPARATION
PROPORTION-DEFORMITY
PROVISION-WASTE
PULPINESS-OILINESS
PULPINESS-ROSIN
PURITY-CRUDENESS
PUSH-PULL
RECURRENCE
REDNESS-GREENNESS
REFUGE-PITFALL
REGULARITY-IRREGULARITY
REMOTENESS-NEARNESS
REVERSAL
RIVER-WIND
ROUNDNESS
SAMENESS-CONTRAST
SCULPTURE
SHARPNESS-BLUNTNESS
SMOOTHNESS-ROUGHNESS
SOLIDITY-RARITY
STRENGTH-WEAKNESS
SUPREMACY-SUBORDINACY
SUSPENSION-SUPPORT
SWIFTNESS-SLOWNESS
TEXTURE
TOUGHNESS-BRITTLENESS
TURBULENCE-CALM
UNIFORMITY-DIVERSITY
UNIFORMITY-MULTIFORMITY
UNION-DISUNION
USEFULNESS-USELESSNESS
VARIATION
VIBRATION
VARIEGATION
VIGOR-INERTIA
VISCIDITY-FOAM
VISIBILITY-INVISIBILITY
WATER-AIR
WHITENESS-BLACKNESS
WHOLE-PART
YELLOWNESS-PURPLE

3. THESAURUS WITH BASE WORDS ARRANGED ALPHABETICALLY

ABLAZE		LUMINOUS	417	BALLED		ROTUND	252
ACUTE		SHARP	256	BALLED-UP		CROSSED	222
ADAPTABLE		FLEXIBLE	327	BALLOONING		CONVEX	253
ADHESIVE	*	COHESIVE	48	BANDED		MOTTLED	437
ADHESIVE	*	RETENTIVE	778	BARBED		SHARP	256
ADHESIVE	*	TOUGH	329	BARE	*	DRY	342
ADHESIVE	*	VISCID	354	BARE	*	PLAIN	573
ADJUSTABLE		CONFORMABLE	83	BARE	*	SIMPLE	44
ADULTERATED		MIXED	43	BARE	*	UNCOVERED	229
AERATED		BUBBLY	355	BARE		WEAKENED	163
AERIFIED		RARE	325	BARRED		CROSSED	222
AFLAME		LUMINOUS	417	BARRED		MOTTLED	437
AGLOW		LUMINOUS	417	BASTED		UNCTUOUS	357
AIR-PROOF		SEALED-OFF	264	BATED		UNSHARPENED	257
AIR-TIGHT		SEALED-OFF	264	BEADLIKE		ROTUND	252
AIRLESS		TRANQUIL	266	BEADY		ROTUND	252
AIRY		GASEOUS	336	BEAMING		LUMINOUS	417
AIRY		INSUBSTANTIA	4	BECLOUDED		UNLIT	418
AIRY		LIGHT	323	BEDDED		LAYERED	207
AIRY		WINDY	352	BEDRAGGLED		DIRTY	649
ALBINO		COLORLESS	426	BEECHY		ARBOREAL	366
ALIGNED		UNIFORM	16	BEEFY	*	FLESHY	195
ALLOYED		MIXED	43	BEFOGGED		UNLIT	418
ALLUVIAL		TERRITORIAL	344	BEGRIMED		DIRTY	649
ALTERABLE		UNSTABLE	152	BELLIED		CELLULAR	194
AMORPHOUS		DISTORTED	246	BELLYING		CONVEX	253
AMORPHOUS		FLUIDAL	335	BENDABLE		SOFT	327
AMORPHOUS		NON-UNIFORM	17	BICOLOR	*	VARIEGATED	437
ANHYDROUS		DRY	342	BILLOWING		CONVEX	253
ARCHED		ARCUATE	253	BILLOWY		CONVEX	253
ARCHED		CONCAVE	255	BITUMINOUS		RESINOUS	357
AREATED		RARE	325	BLACK	*	DIRTY	649
ARID		DRY	342	BLACK		SOFT-HUED	425
ARMORED		HARD	326	BLADDER-LIKE		EXPANDED	197
ARMORED		INVULNERABLE	660	BLANK		CLEAN	648
ARROWY		SHARP	256	BLANK		COLORLESS	426
ASHEN	*	COLORLESS	426	BLANK		INSUBSTANTIA	4
ASHEN	*	GRAY	429	BLANK		OPAQUE	423
ASHEN-HUED		COLORLESS	426	BLEACHED		COLORLESS	426
ASHY	*	COLORLESS	426	BLEACHED		DRY	342
ASHY	*	GRAY	429	BLEARY		DIM	419
ASKEW		DISTORTED	246	BLEMISHED		DEFORMED	246
ASPHALTIC		RESINOUS	357	BLEMISHED		INCOMPLETE	55
ASSORTED		UNIFORM	16	BLEMISHED		MOTTLED	437
AWRY		ORDERLESS	61	BLENDED		MIXED	43
BAGGY		RECEPIENT	194	BLINDING		LUMINOUS	417
BAGGY		SPACIOUS	183	BLISTERED		ROUGH	259
BAKED		DRY	342	BLISTERY		CONVEX	253
BAKED		HEATED	381	BLOATED		CONVEX	253
BALD		HAIRLESS	229	BLOATED		DEFORMED	246

BLOATED	EXPANDED	197	
BLUFF	UNSHARPENED	257	
BLUNT	UNSHARPENED	257	
BLUNT-NOSED	UNSHARPENED	257	
BLUNTED	UNSHARPENED	257	
BLURRED	* AMORPHOUS	244	
BLURRED	* DIM	419	
BLURRY	SHADOWY	419	
BLUSHING	LUMINOUS	417	
BOB-TAILED	INCOMPLETE	55	
BOGGY	MARSHY	347	
BOMB-PROOF	INVULNERABLE	660	
BOMB-PROOF	UNYIELDING	162	
BONY	HARD	326	
BORED	PERFORATED	263	
BOWED	ARCUATE	253	
BRAMBLY	SHARP	256	
BRANCHING	SPACIOUS	183	
BRANCHING	UNASSEMBLED	75	
BRANDED	HEATED	381	
BRANNY	POWDERY	332	
BREAKABLE	BRITTLE	330	
BRIERY	* SHARP	256	
BRIGHT	* CLEAN	648	
BRIGHT	COLORED	425	
BRIGHT	* FLORID	425	
BRIGHT	* LUMINESCENT	420	
BRIGHT	* LUMINOUS	417	
BRIGHT	* UNDIMMED	417	
BRILLIANT	COLORED	425	
BRILLIANT	FLORID	425	
BRILLIANT	LUMINOUS	417	
BRINDED	MOTTLED	437	
BRINDLED	* MOTTLED	437	
BRISTLING	SHARP	256	
BRISTLY	* HAIRY	259	
BRISTLY	* SHARP	256	
BRITTLE	* BRITTLE	330	
BRITTLE	FLIMSY	163	
BRITTLE	INSUBSTANTIA	4	
BRITTLE	POWDERY	332	
BROKEN	DISCONTINUOU	72	
BROKEN	* ROUGH	259	
BROKEN	WEAKENED	163	
BROWN	* DRY	342	
BROWNED	UNCOOKED	670	
BUBBLING	BUBBLY	355	
BUBBLY	AIRY	340	
BUCKLED	* CONVOLUTED	251	
BUCKLED	DISTORTED	246	
BULBOUS	EXPANDED	197	
BUMPY	* DISCONTINUOU	72	
BUMPY	* NON-UNIFORM	17	
BUMPY	* ROUGH	259	
BUOYANT	LIGHT	323	
BURNED	DRY	342	
BURNED	HEATED	381	
BURNISHED	UNDIMMED	417	
BUSHY	ARBOREAL	366	
BUSHY	DENSE	324	
BUSHY	VEGETAL	366	
BUTTERY	FATTY	357	
CAKED	DIRTY	649	
CALLOUS	HARD	326	
CALLOUSED	HARD	326	
CAMBERED	ARCUATE	253	
CAMERATED	CELLULAR	194	
CANALLED	FURROWED	262	
CANESCENT	GRAY	429	
CARIOUS	UNCLEAN	649	
CARTILAGINOU	HARD	326	
CAST-IRON	HARD	326	
CAVERNOUS	CONCAVE	255	
CELLULAR	* CELLULAR	194	
CELLULAR	* CONCAVE	255	
CEMENTED	FIRM-SET	45	
CHALKY	TERRITORIAL	344	
CHAMELEON	IRIDESCENT	437	
CHANGEABLE	TRANSIENT	114	
CHANGEFUL	TRANSIENT	114	
CHANNELED	FURROWED	262	
CHARRED	HEATED	381	
CHECKERED	PIED	437	
CHILLY	COLD	380	
CHUNKY	FLESHY	195	
CLAMMY	COHESIVE	48	
CLAMMY	* VISCID	354	
CLARIFIED	UNMIXED	44	
CLAYEY	TERRITORIAL	344	
CLEAN	PLAIN	573	
CLEAN	* UNMIXED	44	
CLEANED	CLEAN	648	
CLEAR	* ORDERLY	60	
CLEAR	* PERSPICUOUS	567	
CLEAR	* TRANSPARENT	422	
CLEAR	* UNDIMMED	417	
CLEAR	* UNMIXED	44	
CLEAR	* WELL-SEEN	443	
CLEFT	SPACED	201	
CLINGING	* COHESIVE	48	

CLINGING		RETENTIVE	778	COLORLESS	*	COLORLESS	426
CLINGING	*	TOUGH	329	COLORLESS	*	DIM	419
CLOSE		COHESIVE	48	COLORLESS	*	DULL	840
CLOSE		DENSE	324	COLORLESS		INSUBSTANTIA	4
CLOSE		FIRM-SET	45	COLORLESS	*	WEAK	163
CLOSE-FITTIN		ADJUSTED	24	COLUMNAR		ROTUND	252
CLOSE-PACKED		DENSE	324	COMBLIKE		SHARP	256
CLOSE-SET		FIRM-SET	45	COMPACT		COHESIVE	48
CLOSE-TEXTUR		DENSE	324	COMPACT		DENSE	324
CLOSE-WOVEN		TEXTURAL	331	COMPARTMENTA		CELLULAR	194
CLOSE-WOVEN		TOUGH	329	COMPLICATED		COMPLEX	61
CLOSED		CONTRACTED	198	COMPOSITE		MIXED	43
CLOTTED	*	DENSE	324	COMPRESSED		CONTRACTED	198
CLOTTED	*	DIRTY	649	COMPRESSIBLE		CONTRACTED	198
CLOTTED	*	SEMILIQUID	354	COMPRESSIBLE		RARE	325
CLOUDED		OPAQUE	423	COMPRESSIBLE		SOFT	327
CLOUDLESS		UNDIMMED	417	COMPRESSIVE		CONTRACTED	198
CLOUDY	*	CLOUDY	355	CONCRETE		COHESIVE	48
CLOUDY	*	DIM	419	CONCRETE		DENSE	324
CLOUDY	*	HUMID	341	CONCRETE		HARD	326
CLOUDY	*	IMPERSPICUOU	568	CONCRETE		MATERIAL	319
CLOUDY	*	MOTTLED	437	CONDENSED		CONTRACTED	198
CLOUDY	*	OPAQUE	423	CONDENSED		DENSE	324
CLOUDY	*	SEMITRANSPAR	424	CONFORMABLE		REGULAR	81
CLOUDY	*	UNLIT	418	CONFORMING		CONFORMABLE	83
CLOVEN		SPACED	201	CONSISTENT		UNIFORM	16
COAGULATE		COHESIVE	48	CONSPICUOUS		WELL-SEEN	443
COARSE	*	ROUGH	259	CONTORTED		CONVOLUTED	251
COARSE	*	TEXTURAL	331	CONTRACTIBLE		CONTRACTED	198
COARSE	*	UNCLEAN	649	CONTRACTILE		CONTRACTED	198
COARSE-GRAIN		ROUGH	259	CONVEX		CELLULAR	194
COARSE-GRAIN		TEXTURAL	331	CONVEX		EXPANDED	197
COATED		OPAQUE	423	CONVOLUTED		FIBROUS	208
COBWEBBY		DIRTY	649	COOL		COLD	380
COGGED		TOOTHED	256	COOL		GRAY	429
COHESIVE	*	COHESIVE	48	COPSY		ARBOREAL	366
COHESIVE	*	FIRM-SET	45	CORIACEOUS		TOUGH	329
COHESIVE		RETENTIVE	778	CORNEOUS		HARD	326
COHESIVE		TOUGH	329	CORRUGATED	*	ROUGH	259
COHESIVE		VISCID	354	CORRUGATED	*	UNDULATORY	251
COILED		COMPLEX	61	COTTONY		FIBROUS	208
COLLIED		DIRTY	649	CRACKED	*	BLEMISHED	845
COLLOIDAL		SEMILIQUID	354	CRACKED	*	DILAPIDATED	655
COLORED	*	COLORED	425	CRACKED		IMPERFECT	647
COLORED		LUMINOUS	417	CRACKED	*	SPACED	201
COLORFUL	*	COLORED	425	CRAGGY		DIFFICULT	700
COLORFUL	*	FLORID	425	CRAGGY	*	ROUGH	259
COLORFUL	*	LUMINESCENT	420	CRAGGY	*	SHARP	256
COLORFUL	*	LUMINOUS	417	CREAMY	*	FATTY	357
COLORFUL	*	VARIEGATED	437	CREAMY	*	SEMILIQUID	354

CREAMY	* SOFT-HUED	425	
CREASED	FOLDED	261	
CREASY	FOLDED	261	
CRENATE	NOTCHED	260	
CRIMPED	UNDULATORY	251	
CRINKLED	ANGULAR	247	
CRINKLY	UNDULATORY	251	
CRISP	BRITTLE	330	
CRISS-CROSS	CROSSED	222	
CROSS-GRAINE	ROUGH	259	
CROSSED	TEXTURAL	331	
CRUMBLED	POWDERY	332	
CRUMBLING	POWDERY	332	
CRUMBLING	WEAKENED	163	
CRUMBLY	BRITTLE	330	
CRUMBLY	POWDERY	332	
CRUMPLED	CONVOLUTED	251	
CRUMPLED	FOLDED	261	
CRUSHED	FOLDED	261	
CRYSTAL	TRANSPARENT	422	
CRYSTALLINE	* DENSE	324	
CRYSTALLINE	* HARD	326	
CRYSTALLINE	* SYMMETRICAL	245	
CRYSTALLINE	* TRANSPARENT	422	
CRYSTALLIZED	DENSE	324	
CURDLED	SEMILIQUID	354	
CURLY	* HAIRY	259	
CURLY	* UNDULATORY	251	
CUSHIONY	SOFT	327	
CUSPED	SHARP	256	
DAINTY	LITTLE	196	
DAINTY	SMALL	33	
DAMAGED	BLEMISHED	845	
DAMP	HUMID	341	
DAMP-PROOF	DRY	342	
DAMP-PROOF	UNYIELDING	162	
DANGLING	NON-ADHESIVE	49	
DANGLING	PENDENT	217	
DANK	HUMID	341	
DAPPLED	MIXED	43	
DAPPLED	PIED	437	
DARK	* DARK	418	
DARK	* IMPERSPICUOU	568	
DARK	* INVISIBLE	444	
DARK	SOFT-HUED	425	
DARKISH	DIM	419	
DAZZLING	LUMINOUS	417	
DECAYED	ANTIQUATED	127	
DECAYING	WEAKENED	163	
DECKED	LAYERED	207	
DECOLORED	COLORLESS	426	
DECOMPOSED	NON-ADHESIVE	49	
DEEP	FLORID	425	
DEEP-COLORED	COLORED	425	
DEEP-COLORED	FLORID	425	
DEFECTIVE	DEFORMED	246	
DEFICIENT	INCOMPLETE	55	
DEFICIENT	INSUFFICIENT	636	
DEFICIENT	UNEQUIPPED	670	
DEFINITE	* PERSPICUOUS	567	
DEFINITE	* WELL-SEEN	443	
DEFLATED	CONTRACTED	198	
DEFLATED	WEAKENED	163	
DEHYDRATED	DRY	342	
DELICATE	BRITTLE	330	
DELICATE	FLIMSY	163	
DELICATE	SOFT-HUED	425	
DELICATE	TEXTURAL	331	
DENSE	* DENSE	324	
DENSE	* FIRM-SET	45	
DENSE	* UNYIELDING	162	
DENTATE	* NOTCHED	260	
DEPRESSED	CONCAVE	255	
DESICCATED	DRY	342	
DETECTABLE	VISIBLE	443	
DETERIORATED	BLEMISHED	845	
DETERIORATED	CONTRACTED	198	
DETERIORATED	INCOMPLETE	55	
DEWY	* CLEAN	648	
DEWY	* HUMID	341	
DIAPHANOUS	UNDIMMED	417	
DILAPIDATED	BRITTLE	330	
DIM	COLORLESS	426	
DIM	OPAQUE	423	
DIMMED	UNLIT	418	
DINGY	* COLORLESS	426	
DINGY	* DARK	418	
DINGY	* DIM	419	
DINGY	* DIRTY	649	
DINGY	* SOFT-HUED	425	
DIRT-FREE	CLEAN	648	
DIRTY	BLEMISHED	845	
DIRTY	BUBBLY	355	
DIRTY	DIM	419	
DIRTY	* DIRTY	649	
DIRTY	MARSHY	347	
DIRTY	* OPAQUE	423	
DIRTY	POWDERY	332	
DISCOLORED	COLORLESS	426	
DISINFECTED	CLEAN	648	

DISSOLUBLE		LIQUIFIED	337	DUN	*	DIM	419
DISTENDED		EXPANDED	197	DUNGY		UNCLEAN	649
DISTINCT		WELL-SEEN	443	DUSKY		DIM	419
DISTORTED		UNEQUAL	29	DUST-COVERED		POWDERY	332
DISTORTED		UNSIGHTLY	842	DUSTY	*	DIRTY	649
DISTORTED		WEAKENED	163	DUSTY	*	DRY	342
DOG-EARED		DILAPIDATED	655	DUSTY	*	MOTTLED	437
DOG-EARED		FOLDED	261	DUSTY	*	POWDERY	332
DOG-EARED		USED	673	DUSTY	*	SOFT-HUED	425
DOUGHY		LIGHT	323	DYED		COLORED	425
DOUGHY		SOFT	327	EDDYING		FLOWING	350
DOWNY	*	DOWNY	259	EDGED		SHARP	256
DOWNY	*	FIBROUS	208	EDGELESS		UNSHARPENED	257
DOWNY		HAIRY	259	EEL-LIKE		SNAKY	251
DOWNY	*	SMOOTH	258	EFFERVESCENT		BUBBLY	355
DOWNY	*	SOFT	327	EFFERVESCENT		WATERY	339
DRAB	*	DILAPIDATED	655	EFFULGENT		LUMINOUS	417
DRAB	*	DULL	840	EGGSHELL		BRITTLE	330
DRAB	*	SOFT-HUED	425	ELASTIC		RARE	325
DRAB	*	UNIFORM	16	ELASTIC		SOFT	327
DRAINED		DRY	342	ELEMENTAL		SIMPLE	44
DRAWN		CONTRACTED	198	ELONGATED		LONG	203
DREGGY		DIRTY	649	EMBOSSED		SALIENT	254
DREGGY		MARSHY	347	EMBRYONIC		EXIGUOUS	196
DRENCHED		FULL	54	EMPTY		INSUBSTANTIA	4
DRIBBLING		HUMID	341	EMULSIVE	*	SEMILIQUID	354
DRIBBLING		SMALL	33	ENAMELED		ORNAMENTED	844
DRILLED		PERFORATED	263	ENAMELED		SMOOTH	258
DRILLED		UNIFORM	16	ENTANGLED	*	COMPLEX	61
DRIPPING		FLOWING	350	EQUILATERAL		EQUAL	28
DRIPPING		HUMID	341	EQUILATERAL		UNIFORM	16
DRIZZLING		HUMID	341	ESTENSILE		FLEXIBLE	327
DRIZZLY		HUMID	341	ETHEREAL		GASEOUS	336
DROOPING		PENDENT	217	EVAPORABLE		VAPORIFIC	338
DROOPING		WEAK	163	EVAPORATED		DRY	342
DROPPING		FLOWING	350	EVEN		FLAT	216
DROUGHTY		DRY	342	EVEN	*	SMOOTH	258
DROWNED		DRENCHED	341	EVEN	*	STRAIGHT	249
DRUMLY		OPAQUE	423	EVERGREEN		UNYIELDING	162
DRY	*	DRY	342	EVERGREEN		VEGETAL	366
DRY	*	HOT	379	EXPANDED		CONVEX	253
DRY	*	NON-ADHESIVE	49	EXPANDING		EXPANDED	197
DRY	*	UNPRODUCTIVE	172	EXTENDED		LONG	203
DRY		WEAK	163	EXTENSIVE		LONG	203
DUCTILE		FLEXIBLE	327	EYE-CATCHING		WELL-SEEN	443
DULL	*	COLORLESS	426	FADED	*	COLORLESS	426
DULL	*	DIM	419	FADED		DIM	419
DULL	*	GRAY	429	FADED		DRY	342
DULL	*	SOFT-HUED	425	FADED	*	SOFT-HUED	425
DULL		UNSHARPENED	257	FADING		COLORLESS	426

FADING	TRANSIENT	114	
FAINT	DIM	419	
FAINT	* INCONSIDERAB	33	
FAIR	* UNDIMMED	417	
FANGED	TOOTHED	256	
FAST	FIRM-SET	45	
FAST	TIED	45	
FAT	FATTY	357	
FAT	FLESHY	195	
FEATHERY	* DOWNY	259	
FEATHERY	HAIRY	259	
FEATHERY	* LIGHT	323	
FEATURELESS	INSUBSTANTIA	4	
FECAL	UNCLEAN	649	
FENNY	HUMID	341	
FENNY	MARSHY	347	
FERRO-CONCRE	HARD	326	
FESTERING	UNCLEAN	649	
FETID	UNCLEAN	649	
FIBROUS	TOUGH	329	
FIERY	LUMINOUS	417	
FILAMENTOUS	FIBROUS	208	
FILMY	* DIM	419	
FILMY	* LAYERED	207	
FILMY	* OPAQUE	423	
FILMY	* TEXTURAL	331	
FILTHY	DIRTY	649	
FINE	* DRY	342	
FINE	* RARE	325	
FINE	* TEXTURAL	331	
FINE	* TRANSPARENT	422	
FINE-GRAINED	TEXTURAL	331	
FINE-SPUN	FIBROUS	208	
FINE-SPUN	TEXTURAL	331	
FINE-WOVEN	TEXTURAL	331	
FIRE-PROOF	INVULNERABLE	660	
FIRE-PROOF	UNYIELDING	162	
FIRM	* DENSE	324	
FIRM	* FIRM-SET	45	
FIRM	* FIXED	153	
FIRM	* HARD	326	
FIRM	RETENTIVE	778	
FIRM	RIGID	326	
FIRM-PACKED	DENSE	324	
FIRM-PACKED	RIGID	326	
FIRM-SET	RIGID	326	
FIXED	FIRM-SET	45	
FIZZY	BUBBLY	355	
FLABBY	* PULPY	356	
FLABBY	* SOFT	327	
FLABBY	WEAK	163	
FLACCID	SOFT	327	
FLACCID	WEAK	163	
FLAGELLIFORM	FIBROUS	208	
FLAKY	BRITTLE	330	
FLAKY	LAYERED	207	
FLAMING	LUMINOUS	417	
FLAPPING	NON-ADHESIVE	49	
FLARING	FLORID	425	
FLARING	LUMINOUS	417	
FLASHING	LUMINOUS	417	
FLASHY	FLORID	425	
FLAT	SMOOTH	258	
FLAT	SOFT-HUED	425	
FLAT	UNIFORM	16	
FLAT	UNSHARPENED	257	
FLATTENED	UNSHARPENED	257	
FLAUNTING	FLORID	425	
FLAWED	BLEMISHED	845	
FLAWLESS	PERFECT	646	
FLEECY	FIBROUS	208	
FLEECY	HAIRY	259	
FLEECY	SMOOTH	258	
FLEECY	SOFT	327	
FLESHY	CONVEX	253	
FLESHY	EXPANDED	197	
FLESHY	* FATTY	357	
FLESHY	* FLESHY	195	
FLESHY	* PULPY	356	
FLEXIBLE	CONFORMABLE	83	
FLEXIBLE	* FLEXIBLE	327	
FLIMSY	* BRITTLE	330	
FLIMSY	* RARE	325	
FLINTY	HARD	326	
FLOCCULENT	* POWDERY	332	
FLOCCULENT	* SOFT	327	
FLOOD-LIT	LUMINOUS	417	
FLOPPING	NON-ADHESIVE	49	
FLOPPY	NON-ADHESIVE	49	
FLOPPY	SOFT	327	
FLOPPY	WEAK	163	
FLORAL	VEGETAL	366	
FLORID	* FLORID	425	
FLORID	VARIEGATED	437	
FLOURY	* POWDERY	332	
FLOWERY	VEGETAL	366	
FLOWING	FLUIDAL	335	
FLOWING	UNSTABLE	152	
FLUENT	FLUIDAL	335	
FLUFFY	HAIRY	259	

FLUID	*	AMORPHOUS	244
FLUID	*	FLOWING	350
FLUID		NON-ADHESIVE	49
FLUID	*	UNSTABLE	152
FLUIDAL		SOFT	327
FLUORESCENT	*	LUMINESCENT	420
FLUSH		FLAT	216
FLUSH		SMOOTH	258
FLUSH		UNIFORM	16
FLUTED		FURROWED	262
FOAMY	*	BUBBLY	355
FOAMY	*	LIGHT	323
FOGGY		DIM	419
FOGGY		OPAQUE	423
FOLDED		CONVOLUTED	251
FOLDED		FURROWED	262
FOLIATE		LAYERED	207
FOLIATED		LAYERED	207
FORESTAL		ARBOREAL	366
FORESTED		ARBOREAL	366
FORKED		ANGULAR	247
FORKED		CROSSED	222
FORMLESS	*	AMORPHOUS	244
FOSSILIZED		HARD	326
FOUL		UNCLEAN	649
FRAGILE		BRITTLE	330
FRAGILE		FLIMSY	163
FRAGILE		INSUBSTANTIA	4
FRAIL		BRITTLE	330
FRAIL		EPHERMERAL	114
FRAIL		FLIMSY	163
FRAIL		UNSAFE	661
FRANGIBLE		BRITTLE	330
FRANGIBLE		FLIMSY	163
FRAYED		DILAPIDATED	655
FRECKLED		BLEMISHED	845
FRECKLED		MOTTLED	437
FRESH		CLEAN	648
FRESH		COLD	380
FRIABLE		BRITTLE	330
FRIABLE		POWDERY	332
FRIZZY	*	HAIRY	259
FRIZZY	*	UNDULATORY	251
FROST-BOUND		COLD	380
FROSTED		GRAY	429
FROSTED		OPAQUE	423
FROSTY		COLD	380
FROTHY	*	BUBBLY	355
FROTHY	*	LIGHT	323
FROZEN		COHESIVE	48
FROZEN		DENSE	324
FULL-COLORED		FLORID	425
FURCATE	*	ANGULAR	247
FURCATE	*	CROSSED	222
FURRY	*	HAIRY	259
FUSED		HEATED	381
FUSED		MIXED	43
FUSTY		DIRTY	649
FUZZY		AMORPHOUS	244
FUZZY		SHADOWY	419
GASEOUS	*	GASEOUS	336
GASEOUS		INSUBSTANTIA	4
GASEOUS	*	LIGHT	323
GASEOUS		RARE	325
GASSY		GASEOUS	336
GASSY		VAPORIFIC	338
GATHERED		TIED	45
GAUDY		FLORID	425
GAUZY		INSUBSTANTIA	4
GELATINOUS		SEMILIQUID	354
GIMCRACK		BRITTLE	330
GIMCRACK		FLIMSY	163
GIVING		SOFT	327
GIVING		WEAK	163
GLARING		WELL-SEEN	443
GLASSY	*	BRITTLE	330
GLASSY	*	COLORLESS	426
GLASSY	*	DIM	419
GLASSY	*	HARD	326
GLASSY	*	SMOOTH	258
GLASSY	*	TRANSPARENT	422
GLASSY	*	UNDIMMED	417
GLAZED		SMOOTH	258
GLEAMING		UNDIMMED	417
GLINTING		LUMINOUS	417
GLITTERING	*	ORNAMENTED	844
GLITTERY		LUMINOUS	417
GLOBULAR		ROTUND	252
GLOSSLESS		COLORLESS	426
GLOSSY	*	LUMINOUS	417
GLOWING		COLORED	425
GLOWING		FLORID	425
GLOWING		LUMINOUS	417
GLUED	*	FIRM-SET	45
GLUEY		COHESIVE	48
GLUEY		RETENTIVE	778
GLUEY		VISCID	354
GNARLED		AMORPHOUS	244
GNARLED	*	DENSE	324
GNARLED	*	DISTORTED	246

GNARLED	* ROUGH	259	
GORY	FLUIDAL	335	
GOSSAMER	INSUBSTANTIA	4	
GOSSAMERY	TEXTURAL	331	
GRAINED	TEXTURAL	331	
GRANITIC	HARD	326	
GRANULAR	* POWDERY	332	
GRANULAR	* TEXTURAL	331	
GRANULATED	POWDERY	332	
GRASSY	* SOFT	327	
GRASSY	* VEGETAL	366	
GRATED	POWDERY	332	
GRAVELLY	HARD	326	
GRAVELLY	POWDERY	332	
GRAY	* COLORLESS	426	
GRAY	* DIM	419	
GRAY	* UNIFORM	16	
GREASED	SMOOTH	258	
GREASED	UNCTUOUS	357	
GREASY	* DIRTY	649	
GREASY	* SMOOTH	258	
GREASY	* UNCTUOUS	357	
GREEN	* VEGETAL	366	
GRIMY	DIM	419	
GRIMY	DIRTY	649	
GRISTLY	HARD	326	
GRISTLY	TOUGH	329	
GRITTY	HARD	326	
GRITTY	POWDERY	332	
GRITTY	TEXTURAL	331	
GRIZZLED	* GRAY	429	
GRIZZLED	* PIED	437	
GRIZZLY	* GRAY	429	
GROUND	* POWDERY	332	
GROVY	ARBOREAL	366	
GUMMOUS	RESINOUS	357	
GUMMY	* COHESIVE	48	
GUMMY	RETENTIVE	778	
GUMMY	* TOUGH	329	
GUMMY	* VISCID	354	
HAIRY	* FIBROUS	208	
HAIRY	* HAIRY	259	
HAIRY	SHARP	256	
HAND-WOVEN	CROSSED	222	
HANGING	PENDENT	217	
HARD	* HARD	326	
HARD	* IMPERSPICUOU	568	
HARD-GRAINED	ARBOREAL	366	
HARD-GRAINED	VEGETAL	366	
HARDENED	HARD	326	
HAZY	* CLOUDY	355	
HAZY	* DIM	419	
HAZY	* ILL-SEEN	444	
HAZY	* OPAQUE	423	
HEAVY	DENSE	324	
HOARY	GRAY	429	
HODDEN	TEXTURAL	331	
HOLEY	DILAPIDATED	655	
HOLEY	PERFORATED	263	
HOLLOW	INSUBSTANTIA	4	
HOLLOW	RARE	325	
HOMESPUN	SIMPLE	44	
HOMESPUN	TEXTURAL	331	
HOMOGENEOUS	SIMPLE	44	
HONEYCOMBED	CONCAVE	255	
HONEYCOMBED	PERFORATED	263	
HORIZONTAL	FLAT	216	
HORNED	TOOTHED	256	
HORNY	HARD	326	
HUELESS	COLORLESS	426	
HULKY	UNWIELDY	195	
HYALINE	TRANSPARENT	422	
HYDROUS	WATERY	339	
ICE-CAPPED	COLD	380	
ICY	COLD	380	
IMMACULATE	CLEAN	648	
IMMISCIBLE	NON-ADHESIVE	49	
IMMOBILE	STILL	266	
IMMOVABLE	FIRM-SET	45	
IMMOVABLE	STILL	266	
IMPENETRABLE	CLOSED	264	
IMPERMEABLE	CLOSED	264	
IMPERMEABLE	DENSE	324	
IMPERMEABLE	SCREENED	421	
IMPERMEABLE	UNYIELDING	162	
IMPERVIOUS *	CLOSED	264	
IMPERVIOUS *	DENSE	324	
IMPERVIOUS *	OPAQUE	423	
IMPERVIOUS *	SCREENED	421	
IMPOROUS	CLOSED	264	
IMPOROUS	DENSE	324	
IMPRESSIBLE	SOFT	327	
INCANDESCENT*	LUMINESCENT	420	
INCANDESCENT	LUMINOUS	417	
INCOMPRESSIB	DENSE	324	
INCOMPRESSIB	RIGID	326	
INDENTED	CONVOLUTED	251	
INDENTED	UNDULATORY	251	
INDISSOLUBLE	RETENTIVE	778	
INDISTINCT *	DIM	419	

INDISTINCT	*	ILL-SEEN	444
INDISTINCT		SHADOWY	419
INELASTIC		DENSE	324
INELASTIC	*	RIGID	326
INELASTIC	*	TOUGH	329
INELASTIC		UNYIELDING	162
INEXTENSIBLE		RIGID	326
INEXTRICABLE		FIRM-SET	45
INEXTRICABLE		TIED	45
INFLEXIBLE		RIGID	326
INFLEXIBLE		STRAIGHT	249
INFRANGIBLE		UNYIELDING	162
INSOLUBLE	*	INDISSOLUBLE	324
INSUBSTANTIA		BRITTLE	330
INSUBSTANTIA		RARE	325
INSUBSTANTIA		WEAK	163
INTERCONNECT		CORRELATIVE	12
INTERLACED		CROSSED	222
INTERLOCKING		CORRELATIVE	12
INTERVOLVED		TIED	45
INTERWOVEN		CROSSED	222
INTRACTABLE		RIGID	326
INTRICATE		COMPLEX	61
INVARIABLE		UNIFORM	16
IRIDESCENT	*	IRIDESCENT	437
IRIDESCENT		MIXED	43
IRON		HARD	326
JAGGED	*	ANGULAR	247
JAGGED	*	NOTCHED	260
JAGGED	*	ROUGH	259
JAGGY		NOTCHED	260
JAGGY		SHARP	256
JAMMED		FIRM-SET	45
JAMMY		VISCID	354
JASPERED		MOTTLED	437
JELLIED		SEMILIQUID	354
JUICELESS		DRY	342
JUICY		HUMID	341
JUICY		SEMILIQUID	354
JUICY		SOFT	327
JUMBLED		MIXED	43
JUNGLY		ARBOREAL	366
KALEIDOSCOPI		MIXED	43
KEEN		SHARP	256
KINKY		UNDULATORY	251
KNOBBY		ROUGH	259
KNOTTED		COMPLEX	61
KNOTTED	*	CROSSED	222
KNOTTED	*	DENSE	324
KNOTTED	*	ROUGH	259
KNOTTED		TIED	45
KNOTTY	*	DENSE	324
LACK-LUSTER	*	COLORLESS	426
LACK-LUSTER	*	DIM	419
LACQUERED		SMOOTH	258
LACTEAL		SEMILIQUID	354
LACTESCENT		SEMILIQUID	354
LAMBENT		LUMINOUS	417
LAMELLAR		LAYERED	207
LAMINATED		LAYERED	207
LANATE		SMOOTH	258
LANCE-SHAPED		TAPERING	256
LARDY		FATTY	357
LASHED		TIED	45
LASHLIKE		FIBROUS	208
LATHERY		BUBBLY	355
LATTICED		CROSSED	222
LATTICED		SPACED	201
LAX		NON-ADHESIVE	49
LEADEN	*	COLORLESS	426
LEADEN	*	DIM	419
LEADEN	*	GRAY	429
LEADEN	*	WEIGHTY	322
LEAKY		POROUS	263
LEATHERY	*	TOUGH	329
LEVEL		FLAT	216
LEVEL		SMOOTH	258
LEVEL		UNIFORM	16
LIGHT		BUBBLY	355
LIGHT	*	LIGHT	3[illegible]
LIGHT		LUMINOUS	4[illegible]
LIGHT	*	RARE	325
LIGHT		SHALLOW	212
LIGHT	*	SOFT	327
LIGHT	*	SOFT-HUED	425
LIGHT		WEAK	163
LIGHT-COLORE		COLORLESS	426
LIGHT-WEIGHT		LIGHT	323
LIGHTWEIGHT		INSUBSTANTIA	4
LIGHTWEIGHT		WEAK	163
LIMP	*	SOFT	327
LIMP		WEAK	163
LIMPID		PERSPICUOUS	567
LIMPID	*	TRANSPARENT	422
LINED		FURROWED	262
LINED		MOTTLED	437
LINSEY-WOOLS*		MIXED	43
LINSEY-WOOLS*		TEXTURAL	331
LIQUEFIABLE		LIQUIFIED	337
LIQUEFIED		FLUIDAL	335

LIQUID	* AMORPHOUS	244	
LIQUID	FLUIDAL	335	
LIQUID	NON-ADHESIVE	49	
LIQUID	* TRANSPARENT	422	
LITHE	FLEXIBLE	327	
LOAMY	TERRITORIAL	344	
LOOMED	CROSSED	222	
LOOSE	* NON-ADHESIVE	49	
LOOSE	* PENDENT	217	
LOOSE	* UNSTABLE	152	
LOOSE	WEAK	163	
LOOSE-KNIT	NON-ADHESIVE	49	
LUBRICATED	SMOOTH	258	
LUBRICATED	UNCTUOUS	357	
LUCID	PERSPICUOUS	567	
LUCID	UNDIMMED	417	
LUMINESCENT	* LUMINESCENT	420	
LUMINOUS	* LUMINESCENT	420	
LUMINOUS	WELL-SEEN	443	
LUMPISH	FLESHY	195	
LUMPY	* DENSE	324	
LUMPY	FLESHY	195	
LUMPY	* ROUGH	259	
LUMPY	* SEMILIQUID	354	
LUSH	VEGETAL	366	
LUSTERLESS	COLORLESS	426	
LUSTROUS	* LUMINOUS	417	
LUXURIENT	DENSE	324	
MAGGOTY	UNCLEAN	649	
MALLEABLE	* CONFORMABLE	83	
MALLEABLE	* FLEXIBLE	327	
MALLEABLE	* UNSTABLE	152	
MANGY	HAIRLESS	229	
MANIFOLD	* MULTIFORM	82	
MANIFOLD	* VARIEGATED	437	
MARBLED	MOTTLED	437	
MARKED	BLEMISHED	845	
MARSHY	* DIRTY	649	
MARSHY	* HUMID	341	
MARSHY	* MARSHY	347	
MARSHY	* PULPY	356	
MARSHY	SEMILIQUID	354	
MARSHY	SOFT	327	
MASSED	DENSE	324	
MASSIVE	DENSE	324	
MASSIVE	* DENSE	324	
MASSIVE	* WEIGHTY	322	
MASSY	* DENSE	324	
MASSY	* MATERIAL	319	
MASSY	* WEIGHTY	322	
MAT	SOFT-HUED	425	
MATTED	CROSSED	222	
MATTED	DENSE	324	
MATTED	DIRTY	649	
MATTED	HAIRY	259	
MATTERY	FLUIDAL	335	
MAZY	COMPLEX	61	
MAZY	LABYRINTHINE	251	
MEANDERING	FLOWING	350	
MEANDERING	LABYRINTHINE	251	
MEATY	FLESHY	195	
MELLOW	SOFT	327	
MELTING	FLUIDAL	335	
MELTING	SOFT	327	
MELTING	UNSTABLE	152	
MEMBRANOUS	LAYERED	207	
MERCURIAL	UNSTABLE	152	
MESHED	CROSSED	222	
MESHED	SPACED	201	
MILDEWED	* ANTIQUATED	127	
MILDEWED	DILAPIDATED	655	
MILDEWED	DIM	419	
MILKY	* FATTY	357	
MILKY	* SEMILIQUID	354	
MILKY	* SEMITRANSPAR	424	
MILLED	POWDERY	332	
MIRY	MARSHY	347	
MISTED	OPAQUE	423	
MISTED	UNLIT	418	
MISTY	* CLOUDY	355	
MISTY	* DIM	419	
MISTY	* HUMID	341	
MISTY	* ILL-SEEN	444	
MISTY	* INSUBSTANTIA	4	
MISTY	* OPAQUE	423	
MISTY	* SEMITRANSPAR	424	
MOIRE	* IRIDESCENT	437	
MOIST	* HUMID	341	
MOIST	* WATERY	339	
MOLDABLE	FLEXIBLE	327	
MOLDING	COHESIVE	48	
MOLE	GRAY	429	
MOLTEN	LIQUIFIED	337	
MONOLITHIC	COHESIVE	48	
MONOLITHIC	SIMPLE	44	
MOORISH	MARSHY	347	
MOORY	MARSHY	347	
MOSAIC	MULTIFORM	82	
MOSAIC	VARIEGATED	437	
MOSS-GROWN	* DILAPIDATED	655	

MOSSY		MARSHY	347	OILED	*	SMOOTH	258
MOSSY	*	SOFT	327	OILED	*	UNCTUOUS	357
MOSSY		VEGETAL	366	OILY	*	DIRTY	649
MOTH-EATEN		DILAPIDATED	655	OILY	*	SMOOTH	258
MOTH-EATEN		DIRTY	649	OILY	*	UNCTUOUS	357
MOTLEY		MIXED	43	OOZY	*	FLOWING	350
MOTLEY		MULTIFORM	82	OOZY	*	HUMID	341
MOTLEY		VARIEGATED	437	OOZY	*	MARSHY	347
MOUSY	*	COLORLESS	426	OPACIOUS		OPAQUE	423
MOUSY	*	GRAY	429	OPALESCENT	*	IRIDESCENT	437
MUCILAGINOUS	*	VISCID	354	OPALESCENT	*	SEMITRANSPAR	424
MUCKY		DIRTY	649	OPALINE	*	IRIDESCENT	437
MUCKY		MARSHY	347	OPALINE	*	SEMITRANSPAR	424
MUCOUS	*	VISCID	354	OPAQUE		IMPERSPICUOU	568
MUDDY	*	DIM	419	OPAQUE		UNLIT	418
MUDDY	*	DIRTY	649	PADDED		SOFT	327
MUDDY	*	HUMID	341	PALE	*	COLORLESS	426
MUDDY	*	MARSHY	347	PALE		DIM	419
MUDDY	*	OPAQUE	423	PALE		INSUBSTANTIA	4
MUDDY	*	SEMILIQUID	354	PALE	*	SOFT-HUED	425
MULTICOLORED		VARIEGATED	437	PALE	*	WEAK	163
MULTIFOLD		MULTIFORM	82	PALLID		COLORLESS	426
MULTIFORM		MIXED	43	PALPABLE		VISIBLE	443
MULTIFORM		VARIEGATED	437	PANED		VARIEGATED	437
MUMMIFIED		DRY	342	PANELED		VARIEGATED	437
MURKY	*	DARK	418	PAPER		INSUBSTANTIA	4
MURKY	*	DENSE	324	PARCHED		DRY	342
MURKY	*	OPAQUE	423	PARTICOLORED		VARIEGATED	437
MUSHY		MARSHY	347	PASTEL		SOFT-HUED	425
MUSHY		SEMILIQUID	354	PASTY	*	COLORLESS	426
MUSHY		SOFT	327	PASTY	*	PULPY	356
MUSTY	*	DIRTY	649	PATCHED		DIRTY	649
MYRRHY		RESINOUS	357	PATCHED		MIXED	43
NAPLESS	*	HAIRLESS	229	PATCHED		VARIEGATED	437
NAPPY	*	DOWNY	259	PATCHY	*	MIXED	43
NAPPY		HAIRY	259	PATCHY		PIED	437
NEEDLELIKE		SHARP	256	PATINATED		SOFT-HUED	425
NEON		LUMINESCENT	420	PATTERNED		UNIFORM	16
NETTED		CROSSED	222	PATTERNLESS		NON-UNIFORM	17
NEUTRAL		GRAY	429	PEACHY	*	DOWNY	259
NODULAR		ROUGH	259	PEACHY		HAIRY	259
NON-DURABLE		EPHEMERAL	114	PEARLY	*	GRAY	429
NOTCHED		ANGULAR	247	PEARLY	*	IRIDESCENT	437
NOTCHED		CONVOLUTED	251	PEARLY	*	SEMITRANSPAR	424
NOTCHED		SHARP	256	PEARLY	*	SOFT-HUED	425
NOTCHED	*	TOOTHED	256	PEBBLY		HARD	326
NOTCHY		NOTCHED	260	PECTINATED		SHARP	256
NUBBLY		ROUGH	259	PELLUCID		UNDIMMED	417
OBDURATE		RIGID	326	PENDENT		NON-ADHESIVE	49
OBSCURED		UNLIT	418	PENDULOUS		NON-ADHESIVE	49

PENDULOUS	PENDENT		217
PENSILE	PENDENT		217
PEPPERED	PERFORATED		263
PERCEPTIBLE	VISIBLE		443
PERCOLATING	POROUS		263
PERISTALTIC	SNAKY		251
PETRIFIED	HARD		326
PETRIFIED	STILL		266
PHLEGMATIC	VISCID		354
PHOSPHORESCE	LUMINESCENT		420
PIEBALD	* PIED		437
PIED	* PIED		437
PILLOWY	SOFT		327
PIMPLED	* CONVEX		253
PIMPLY	CONVEX		253
PINCHED	CONTRACTED		198
PINTO	PIED		437
PITCHY	* DARK		418
PITCHY	* RESINOUS		357
PITHY	SOFT		327
PITTED	* BLEMISHED		845
PITTED	* ROUGH		259
PITUITOUS	VISCID		354
PLAID	VARIEGATED		437
PLAIN	* WELL-SEEN		443
PLAITED	CROSSED		222
PLANE	FLAT		216
PLASMATIC	FLUIDAL		335
PLASTIC	* FLEXIBLE		327
PLASTIC	* UNSTABLE		152
PLIABLE	* FLEXIBLE		327
PLIANT	CONFORMABLE		83
PLIANT	FLEXIBLE		327
PLUMP	* FLESHY		195
PLUMPISH	FLESHY		195
PLUSHY	SOFT		327
PLUVIAL	HUMID		341
POACHY	MARSHY		347
POCK-MARKED	BLEMISHED		845
POCKMARKED	MOTTLED		437
POLISHED	CLEAN		648
POLISHED	ORNAMENTED		844
POLISHED	SMOOTH		258
POLISHED	UNDIMMED		417
POROUS	CONCAVE		255
POT-HOLED	ROUGH		259
POUCHY	EXPANDED		197
POWDERY	* BRITTLE		330
POWDERY	* DRY		342
POWDERY	* POWDERY		332
PRICKLY	SHARP		256
PUCKERY	FOLDED		261
PUDDLED	OPAQUE		423
PUFFY	* EXPANDED		197
PUFFY	* FLESHY		195
PUFFY	* UNSTABLE		152
PULPY	* PULPY		356
PULPY	* SEMILIQUID		354
PULPY	* SOFT		327
PURE	CLEAN		648
PURE	UNMIXED		44
PUSSY	FLUIDAL		335
QUAGGY	MARSHY		347
RADIANT	* LUMINESCENT		420
RADIANT	* LUMINOUS		417
RADIANT	* RADIATING		417
RAGGED	CONVOLUTED		251
RAGGED	UNDULATORY		251
RAINBOW	VARIEGATED		437
RANK	VEGETAL		366
RAVELED	CROSSED		222
RAW	AMORPHOUS		244
REFLECTING	LUMINOUS		417
REFLECTING	* RADIATING		417
REFRACTIVE	LUMINOUS		417
REFULGENT	LUMINOUS		417
REGULAR	UNIFORM		16
RELAXED	NON-ADHESIVE		49
RELAXED	WEAK		163
RESINY	RESINOUS		357
RIBBED	* TEXTURAL		331
RICKETY	WEAK		163
RIDDLED	PERFORATED		263
RIFLED	FURROWED		262
RIGID	DENSE		324
RIGID	STRAIGHT		249
RIGID	TOUGH		329
RIPPLED	FURROWED		262
RIPPLING	FLOWING		350
RIPPLING	ROUGH		259
ROAN	* PIED		437
ROCKY	HARD		326
ROCKY	UNSTABLE		152
ROPY	* DENSE		324
ROPY	* FIBROUS		208
ROPY	* SEMILIQUID		354
ROPY	* THICK		205
ROTTED	UNCLEAN		649
ROTTEN	DILAPIDATED		655
ROTTEN	WEAKENED		163

ROUGH	*	AMORPHOUS	244
ROUGH	*	NON-UNIFORM	17
ROUGH	*	ROUGH	259
ROUGH		TEXTURAL	331
ROUGH-HEWN	*	ROUGH	259
ROUND		FLESHY	195
RUBBERY		TOUGH	329
RUDDY	*	FLORID	425
RUGGED	*	AMORPHOUS	244
RUNNING		FLUIDAL	335
RUNNING		UNSTABLE	152
RUNNY		FLUIDAL	335
RUNNY		LIQUIFIED	337
RUNNY		NON-ADHESIVE	49
RUSTED		DIM	419
RUSTING		WEAKENED	163
RUSTY		DILAPIDATED	655
RUSTY	*	DIM	419
RUSTY	*	UNSHARPENED	257
RUTTY		FURROWED	262
SANDY	*	DRY	342
SANDY	*	POWDERY	332
SAPLESS		DRY	342
SAPPY		FLUIDAL	335
SAPPY		SEMILIQUID	354
SATINY		SMOOTH	258
SATINY		TEXTURAL	331
SATURATED		DRENCHED	341
SCABBY		ROUGH	259
SCABBY		UNCLEAN	649
SCALLOPED		UNDULATORY	251
SCALY	*	LAYERED	207
SCARRED		BLEMISHED	845
SCINTILLATIN		LUMINOUS	417
SCLEROTIC		HARD	326
SCREENED		UNLIT	418
SCRUBBY	*	ARBOREAL	366
SCUMMY		BUBBLY	355
SEAMED		LAYERED	207
SEBACEOUS		FATTY	357
SEC[illegible]RE		FIRM-SET	45
SEC[illegible]		TIED	45
S[illegible]ACHED		NON-ADHESIVE	49
SE[illegible]		SEMILIQUID	354
SE[illegible]		TOUGH	329
SEP[illegible]		NON-ADHESIVE	49
SERE		DRY	342
SERE		LEAN	206
SERPENTINE		LABYRINTHINE	251
SERPENTINE		SNAKY	251
SERRATED		ANGULAR	247
SERRATED		NOTCHED	260
SERRATED		TOOTHED	256
SET		FIRM-SET	45
SEVERABLE		BRITTLE	330
SEWN		TIED	45
SHABBY		DILAPIDATED	655
SHADED		SHADOWY	419
SHADOWLESS		UNDIMMED	417
SHADOWY		AMORPHOUS	244
SHADOWY		INSUBSTANTIA	4
SHADOWY		SCREENED	421
SHADY		SCREENED	421
SHADY		SHADOWY	419
SHAGGED		HAIRY	259
SHAGGY		HAIRY	259
SHAKY		FLIMSY	163
SHALY		LAYERED	207
SHARP		NOTCHED	260
SHATTERY	*	BRITTLE	330
SHATTERY	*	FLIMSY	163
SHEENY		LUMINOUS	417
SHEER	*	TRANSPARENT	422
SHINING		CLEAN	648
SHINING		LUMINESCENT	420
SHINING		LUMINOUS	417
SHINING		WELL-SEEN	443
SHINY	*	CLEAN	648
SHINY	*	LUMINOUS	417
SHINY	*	SMOOTH	258
SHIVERY		BRITTLE	330
SHODDY		FLIMSY	163
SHRIVELED		DRY	342
SHRUBBY		ARBOREAL	366
SHRUNK	*	CONTRACTED	198
SHUFFLED		ORDERLESS	61
SIFTED		POWDERY	332
SILKEN		SMOOTH	258
SILKY		FIBROUS	208
SILKY	*	SMOOTH	258
SILKY	*	SOFT	327
SILKY	*	TEXTURAL	331
SILTY		MARSHY	347
SILTY		SEMILIQUID	354
SILVERY		GRAY	429
SIMILAR		UNIFORM	16
SINUOUS	*	CONVOLUTED	251
SLABBY	*	MARSHY	347
SLABBY	*	SEMILIQUID	354
SLACK	*	NON-ADHESIVE	49

SLACK	* ORDERLESS	61	
SLACK	* WEAK	263	
SLATY	* LAYERED	207	
SLEAZY	FLIMSY	163	
SLEEK	* SMOOTH	258	
SLICK	SMOOTH	258	
SLIGHT	WEAK	163	
SLIMY	* DIRTY	649	
SLIMY	HUMID	341	
SLIMY	MARSHY	347	
SLIMY	SEMILIQUID	354	
SLIPPERY	* NON-ADHESIVE	49	
SLIPPERY	* SMOOTH	258	
SLIPPERY	* UNCTUOUS	357	
SLITHERY	SMOOTH	258	
SLOPPING	DRENCHED	341	
SLUMMY	UNCLEAN	649	
SLUSHY	HUMID	341	
SLUSHY	MARSHY	347	
SLUSHY	SEMILIQUID	354	
SMALL	CONTRACTED	198	
SMALL	WEAK	163	
SMOKY	* DIM	419	
SMOKY	* DIRTY	649	
SMOKY	GRAY	429	
SMOKY	* OPAQUE	423	
SMOKY	* POWDERY	332	
SMOKY	* VAPORIFIC	338	
SMOOTH	FLAT	216	
SMOOTH	HAIRLESS	229	
SMOOTH	* NON-ADHESIVE	49	
SMOOTH	* ORDERLY	60	
SMOOTH	* REGULAR	81	
SMOOTH	* SMOOTH	258	
SMOOTH	* SOFT	327	
SMOOTH	TEXTURAL	331	
SMOOTH	* UNIFORM	16	
SMOOTH-TEXTU	SMOOTH	258	
SNAGGY	* SHARP	256	
SNAKY	* SNAKY	251	
SNARLED	* COMPLEX	61	
SNUB	UNSHARPENED	257	
SOAKED	DRENCHED	341	
SOAPY	BUBBLY	355	
SOAPY	* FATTY	357	
SOAPY	* SMOOTH	258	
SODDEN	DRENCHED	341	
SOFT	* FLUIDAL	335	
SOFT	LUMINOUS	417	
SOFT	* SMOOTH	258	
SOFT	* SOFT	327	
SOFT	SOFT-HUED	425	
SOFT	* UNSTABLE	152	
SOFT	* WEAK	263	
SOFT-GRAINED	ARBOREAL	366	
SOFT-GRAINED	VEGETAL	366	
SOGGY	MARSHY	347	
SOGGY	* PULPY	356	
SOGGY	SOFT	327	
SOILED	BLEMISHED	845	
SOILED	DIRTY	649	
SOLID	COHESIVE	48	
SOLID	DENSE	324	
SOLID	FIRM-SET	45	
SOLID	THICK	205	
SOLIDIFIED	DENSE	324	
SOLIDIFIED	FIRM-SET	45	
SOLUBLE	FLUIDAL	335	
SOLUBLE	LIQUIFIED	337	
SOLVENT	LIQUIFIED	337	
SOOTY	* DIM	419	
SOOTY	* DIRTY	649	
SOOTY	* OPAQUE	423	
SOOTY	POWDERY	332	
SOUPY	SEMILIQUID	354	
SPARKLING	* BUBBLY	355	
SPARKLING	LUMINOUS	417	
SPECKLED	MOTTLED	437	
SPIDERY	LEAN	206	
SPIKED	SHARP	256	
SPIKY	* SHARP	256	
SPINDLY	LEAN	206	
SPINOUS	SHARP	256	
SPINY	* SHARP	256	
SPIRAL	COILED	251	
SPIRALING	COILED	251	
SPLINTERY	* BRITTLE	330	
SPLIT	SPACED	201	
SPOILED	BLEMISHED	845	
SPONGY	* MARSHY	347	
SPONGY	POROUS	263	
SPONGY	* PULPY	356	
SPONGY	RARE	325	
SPONGY	* SOFT	327	
SPOTLESS	CLEAN	648	
SPOTTED	BLEMISHED	845	
SPOTTED	MOTTLED	437	
SPOTTY	* BLEMISHED	845	
SPOTTY	* MOTTLED	437	
SPRINGLESS	RIGID	326	

SPRINGLESS	TOUGH	329	
SPRINGY	* SOFT	327	
SPRINKLED	HUMID	341	
SPUMY	BUBBLY	355	
SPURRED	SHARP	256	
SQELCHY	HUMID	341	
SQUALID	UNCLEAN	649	
SQUAMOUS	* LAYERED	207	
SQUASHY	* FLUIDAL	335	
SQUASHY	* HUMID	341	
SQUASHY	* MARSHY	347	
SQUASHY	* SEMILIQUID	354	
SQUASHY	* SOFT	327	
SQUELCHY	MARSHY	347	
SQUELCHY	SEMILIQUID	354	
SQUELCHY	SOFT	327	
STAGNATING	QUIESCENT	266	
STAINED	BLEMISHED	845	
STAINED	DIRTY	649	
STAINLESS	* CLEAN	648	
STANDARDIZED	REGULAR	81	
STANDARDIZED	UNIFORM	16	
STARCHED	CLEAN	648	
STARCHED	RIGID	326	
STARCHY	* HARD	326	
STARCHY	RIGID	326	
STARCHY	* SEMILIQUID	354	
STEAMING	BUBBLY	355	
STEAMY	BUBBLY	355	
STEAMY	GASEOUS	336	
STEAMY	VAPORIFIC	338	
STEELY	GRAY	429	
STEELY	* HARD	326	
STEELY	* STRONG	162	
STICKY	* COHESIVE	48	
STICKY	RETENTIVE	778	
STICKY	TOUGH	329	
STICKY	* VISCID	354	
STIFF	* RIGID	326	
STIRRED	MIXED	43	
STITCHED	TIED	45	
STODGY	SEMILIQUID	354	
STONY	* HARD	326	
STONY	* ROUGH	259	
STORIED	LAYERED	207	
STRANGLED	CONTRACTED	198	
STRANGULATED	CONTRACTED	198	
STRATIFIED	LAYERED	207	
STRATIFORM	* LAYERED	207	
STREAKED	MOTTLED	437	
STREAKY	MOTTLED	437	
STREAMING	* NON-ADHESIVE	49	
STRETCHABLE	FLEXIBLE	327	
STRETCHED	EXPANDED	197	
STRIATED	FURROWED	262	
STRIATED	MOTTLED	437	
STRIKING	WELL-SEEN	443	
STRINGY	* FIBROUS	208	
STRINGY	* TOUGH	329	
STRIPED	MOTTLED	437	
STRIPPED	WEAKENED	163	
STRONG	THICK	205	
STRONG-FIBER	TOUGH	329	
STUBBY	* THICK	205	
STUBBY	* UNSHARPENED	257	
STUDDED	ROUGH	259	
STUDDED	SHARP	256	
SUBTILE	RARE	325	
SUBTILE	TEXTURAL	331	
SUNDRIED	DRY	342	
SUPPLE	FLEXIBLE	327	
SUSPENDED	PENDENT	217	
SWAMPY	MARSHY	347	
SWOLLEN	EXPANDED	197	
SYLVAN	ARBOREAL	366	
SYMMETRICAL	UNIFORM	16	
SYRUPY	VISCID	354	
TABBY	MOTTLED	437	
TABULAR	LAYERED	207	
TACKY	VISCID	354	
TANGLED	* DENSE	324	
TANGLED	MIXED	43	
TANGLED	* TIED	45	
TARNISHED	DIRTY	649	
TARRY	RESINOUS	357	
TATTY	DILAPIDATED	655	
TAUT	* RIGID	326	
TAUT	* TIED	45	
TEARABLE	BRITTLE	330	
TEARABLE	FLIMSY	163	
TEMPERED	HARD	326	
TENDER	SOFT	327	
TENDER	* SOFT-HUED	425	
TENSE	RIGID	326	
TENSE	TIED	45	
TENUOUS	FLIMSY	163	
TENUOUS	INSUBSTANTIA	4	
TENUOUS	RARE	325	
TEXTILE	CROSSED	222	
TEXTILE	TEXTURAL	331	

TEXTURAL	* TEXTURAL	331	
THAWING	SEMILIQUID	354	
THICK	BUBBLY	355	
THICK	* DENSE	324	
THICK	* DIM	419	
THICK	DIRTY	649	
THICK	FIBROUS	208	
THICK	* OPAQUE	423	
THICK	* SEMILIQUID	354	
THICK-GROWIN	DENSE	324	
THICK-RIBBED	THICK	205	
THICKSET	* DENSE	324	
THICKSET	* THICK	205	
THIN	HAIRLESS	229	
THIN	INSUBSTANTIA	4	
THIN	RARE	325	
THIN	* TRANSPARENT	422	
THIN	WEAK	163	
THISTLY	SHARP	256	
THORNY	* SHARP	256	
THREADBARE	* DIRTY	649	
THREADBARE	* HAIRLESS	229	
TIED	COMPLEX	61	
TIGHT	* COHESIVE	48	
TIGHT	CONTRACTED	198	
TIGHT	* DRY	342	
TIGHT	EXPANDED	197	
TIGHT	* FIRM-SET	45	
TIGHT	* RIGID	326	
TIGHT	TIED	45	
TIGHT-STRUNG	RIGID	326	
TIMBERED	ARBOREAL	366	
TINGED	COLORED	425	
TINTED	COLORED	425	
TOOTHED	NOTCHED	260	
TOOTHLESS	UNSHARPENED	257	
TOOTHY	TOOTHED	256	
TOTTERY	WEAK	163	
TOUGH	COHESIVE	48	
TOUGH	* HARD	326	
TOUGH	* STRONG	162	
TOUGH	* TOUGH	329	
TOUGHENED	STRONG	162	
TOUGHENED	TOUGH	329	
TRACTILE	FLEXIBLE	327	
TRANSLUCENT	* TRANSPARENT	422	
TRANSLUCENT	* UNDIMMED	417	
TRANSPARENT	* INSUBSTANTIA	4	
TRANSPARENT	PERSPICUOUS	567	
TRANSPARENT	* TRANSPARENT	422	
TRANSPARENT	* UNDIMMED	417	
TRANSPICUOUS	TRANSPARENT	422	
TREACLY	VISCID	354	
TRICOLOR	* VARIEGATED	437	
TUFTY	HAIRY	259	
TUMBLEDOWN	BRITTLE	330	
TUMESCENT	EXPANDED	197	
TUMID	EXPANDED	197	
TURBID	OPAQUE	423	
TURFEN	VEGETAL	366	
TURFY	VEGETAL	366	
TURFY	SOFT	327	
TURGESCENT	EXPANDED	197	
TURGID	* EXPANDED	197	
TURNING	LABYRINTHINE	251	
TUSKED	TOOTHED	256	
TUSKY	TOOTHED	256	
TWEEDY	CROSSED	222	
TWILIGHT	DIM	419	
TWILLED	TEXTURAL	331	
TWINING	CONVOLUTED	251	
TWISTED	CONVOLUTED	251	
TWISTING	LABYRINTHINE	251	
UMBRAGEOUS	SCREENED	421	
UNATTACHED	UNSTABLE	152	
UNBENT	STRAIGHT	249	
UNDILUTED	UNMIXED	44	
UNHEWN	AMORPHOUS	244	
UNIFIED	SIMPLE	44	
UNIFORM	COHESIVE	48	
UNIFORM	SIMPLE	44	
UNIQUE	NON-UNIFORM	17	
UNRAVELED	SIMPLE	44	
UNSTABLE	WEAK	163	
VACUOUS	INSUBSTANTIA	4	
VAGUE	SHADOWY	419	
VAPORABLE	VAPORIFIC	338	
VAPORISH	VAPORIFIC	338	
VAPORIZABLE	VAPORIFIC	338	
VAPOROUS	* GASEOUS	336	
VAPOROUS	* INSUBSTANTIA	4	
VAPOROUS	* OPAQUE	423	
VAPOROUS	* VAPORIFIC	338	
VAPORY	VAPORIFIC	338	
VARIFORM	MULTIFORM	82	
VARNISHED	RESINOUS	357	
VARNISHED	SMOOTH	258	
VEINED	MOTTLED	437	
VELVETY	* DOWNY	259	
VELVETY	HAIRY	259	

VELVETY	* SMOOTH	258	
VELVETY	* SOFT	327	
VERDANT	VEGETAL	366	
VERSICOLOR	IRIDESCENT	437	
VISCID	COHESIVE	48	
VISCID	* THICK	205	
VISCID	TOUGH	329	
VISCOUS	* COHESIVE	48	
VITREOUS	HARD	326	
VITREOUS	TRANSPARENT	422	
VIVID	COLORED	425	
VIVID	FLORID	425	
VIVID	LUMINOUS	417	
VOLATILE	TRANSIENT	114	
VOLATILE	VAPORIFIC	338	
VULCANIZED	TOUGH	329	
WAN	DIM	419	
WANING	DIM	419	
WARTY	CONVEX	253	
WATER LOGGED	MARSHY	347	
WATERED	MIXED	43	
WATERLESS	DRY	342	
WATERLOGGED	DRENCHED	341	
WATERY	FLUIDAL	335	
WATERY	* HUMID	341	
WATERY	MARSHY	347	
WATERY	* NON-ADHESIVE	49	
WATERY	* WATERY	339	
WATERY	* WEAK	163	
WAVY	UNDULATORY	251	
WAXED	SMOOTH	258	
WAXEN	* FATTY	357	
WAXY	* FATTY	357	
WAXY	* SOFT	327	
WEAK	BRITTLE	330	
WEATHER-BEAT*	DILAPIDATED	655	
WEATHER-BEAT*	WEAKENED	163	
WEATHERED	SOFT-HUED	425	
WEBBED	CROSSED	222	
WEBBY	CROSSED	222	
WEDGED	FIRM-SET	45	
WEEDY	VEGETAL	366	
WEIGHTED	WEIGHTY	322	
WEIGHTLESS	LIGHT	323	
WEIGHTY	DENSE	324	
WEIGHTY	MATERIAL	319	
WELL-BRUSHED	SMOOTH	258	
WELL-DEFINED	WELL-SEEN	443	
WELL-KNIT	COHESIVE	48	
WELL-LIT	LUMINESCENT	420	
WELL-LIT	LUMINOUS	417	
WELL-MARKED	WELL-SEEN	443	
WELL-THUMBED	USED	673	
WELL-TIED	TIED	45	
WELL-WORN	DILAPIDATED	655	
WELL-WORN	USED	673	
WET	HUMID	341	
WET	WATERY	339	
WETTED	HUMID	341	
WHETTED	SHARP	256	
WHIFFLING	UNSTABLE	152	
WHIPPED	LIGHT	323	
WHIPPY	FLEXIBLE	327	
WHISKERY	FIBROUS	208	
WHORLED	COILED	251	
WIDESPREAD	EXPANDED	197	
WILD	ARBOREAL	366	
WIND-DRIED	DRY	342	
WINDING	COMPLEX	61	
WINDING	* CONVOLUTED	251	
WINDY	* AIRY	340	
WINDY	* GASEOUS	336	
WIRE-DRAWN	FIBROUS	208	
WIRY	* FIBROUS	208	
WISPY	FLIMSY	163	
WISPY	RARE	325	
WITHERED	DRY	342	
WITHERED	WEAKENED	163	
WOBBLING	UNSTABLE	152	
WOBBLY	WEAK	163	
WOOD	ARBOREAL	366	
WOODED	ARBOREAL	366	
WOODEN	ARBOREAL	366	
WOODLAND	ARBOREAL	366	
WOODY	ARBOREAL	366	
WOODY	VEGETAL	366	
WOOLLY	* HAIRY	259	
WOOLLY	* SMOOTH	258	
WOOLLY	UNDULATORY	251	
WOOLY	FIBROUS	208	
WORN	* DILAPIDATED	655	
WORN	* USED	673	
WORN	* WEAKENED	163	
WOVEN	* CROSSED	222	
WOVEN	* TEXTURAL	331	
WRIGGLING	SNAKY	251	
WRINKLED	FURROWED	262	
WRINKLED	ROUGH	259	
WRINKLED	UNDULATORY	251	
WRINKLY	FOLDED	261	

YEASTY	*	BUBBLY	355
YEASTY	*	LIGHT	323
YIELDING		SOFT	327
YIELDING		UNSTABLE	152
YIELDING		WEAK	163
ZIGZAG	*	ANGULAR	247
ZONED		LAYERED	207

4. THESAURUS WITH SUBHEADINGS ARRANGED ALPHABETICALLY

CLOSE-FITTIN		ADJUSTED	24	FRECKLED		BLEMISHED	845
BUBBLY		AIRY	340	MARKED		BLEMISHED	845
WINDY	*	AIRY	340	PITTED	*	BLEMISHED	845
BLURRED	*	AMORPHOUS	244	POCK-MARKED		BLEMISHED	845
FLUID	*	AMORPHOUS	244	SCARRED		BLEMISHED	845
FORMLESS	*	AMORPHOUS	244	SOILED		BLEMISHED	845
FUZZY		AMORPHOUS	244	SPOILED		BLEMISHED	845
GNARLED		AMORPHOUS	244	SPOTTED		BLEMISHED	845
LIQUID	*	AMORPHOUS	244	SPOTTY	*	BLEMISHED	845
RAW		AMORPHOUS	244	STAINED		BLEMISHED	845
ROUGH	*	AMORPHOUS	244	BREAKABLE		BRITTLE	330
RUGGED	*	AMORPHOUS	244	BRITTLE	*	BRITTLE	330
SHADOWY		AMORPHOUS	244	CRISP		BRITTLE	330
UNHEWN		AMORPHOUS	244	CRUMBLY		BRITTLE	330
CRINKLED		ANGULAR	247	DELICATE		BRITTLE	330
FORKED		ANGULAR	247	DILAPIDATED		BRITTLE	330
FURCATE	*	ANGULAR	247	EGGSHELL		BRITTLE	330
JAGGED	*	ANGULAR	247	FLAKY		BRITTLE	330
NOTCHED		ANGULAR	247	FLIMSY	*	BRITTLE	330
SERRATED		ANGULAR	247	FRAGILE		BRITTLE	330
ZIGZAG	*	ANGULAR	247	FRAIL		BRITTLE	330
DECAYED		ANTIQUATED	127	FRANGIBLE		BRITTLE	330
MILDEWED	*	ANTIQUATED	127	FRIABLE		BRITTLE	330
BEECHY		ARBOREAL	366	GIMCRACK		BRITTLE	330
BUSHY		ARBOREAL	366	GLASSY	*	BRITTLE	330
COPSY		ARBOREAL	366	INSUBSTANTIA		BRITTLE	330
FORESTAL		ARBOREAL	366	POWDERY	*	BRITTLE	330
FORESTED		ARBOREAL	366	TEARABLE		BRITTLE	330
GROVY		ARBOREAL	366	WAFTERY	*	BRITTLE	330
HARD-GRAINED		ARBOREAL	366	SHIVERY		BRITTLE	330
JUNGLY		ARBOREAL	366	SPLINTERY	*	BRITTLE	330
SCRUBBY	*	ARBOREAL	366	TEARABLE		BRITTLE	330
SHRUBBY		ARBOREAL	366	TUMBLEDOWN		BRITTLE	330
SOFT-GRAINED		ARBOREAL	366	WEAK		BRITTLE	330
SYLVAN		ARBOREAL	366	AERATED		BUBBLY	355
TIMBERED		ARBOREAL	366	BUBBLING		BUBBLY	355
WILD		ARBOREAL	366	DIRTY		BUBBLY	355
WOOD		ARBOREAL	366	EFFERVESCENT		BUBBLY	355
WOODED		ARBOREAL	366	FIZZY		BUBBLY	355
WOODEN		ARBOREAL	366	FOAMY	*	BUBBLY	355
WOODLAND		ARBOREAL	366	FROTHY	*	BUBBLY	355
WOODY		ARBOREAL	366	LATHERY		BUBBLY	355
ARCHED		ARCUATE	253	LIGHT		BUBBLY	355
BOWED		ARCUATE	253	SCUMMY		BUBBLY	355
CAMBERED		ARCUATE	253	SOAPY		BUBBLY	355
CRACKED	*	BLEMISHED	845	SPARKLING	*	BUBBLY	355
DAMAGED		BLEMISHED	845	SPUMY		BUBBLY	355
DETERIORATED		BLEMISHED	845	STEAMING		BUBBLY	355
DIRTY		BLEMISHED	845	STEAMY		BUBBLY	355
FLAWED		BLEMISHED	845	THICK		BUBBLY	355

YEASTY	*	BUBBLY	355	SPIRALING		COILED	251
BELLIED		CELLULAR	194	WHORLED		COILED	251
CAMERATED		CELLULAR	194	CHILLY		COLD	380
CELLULAR	*	CELLULAR	194	COOL		COLD	380
COMPARTMENTA		CELLULAR	194	FRESH		COLD	380
CONVEX		CELLULAR	194	FROST-BOUND		COLD	380
BLANK		CLEAN	648	FROSTY		COLD	380
BRIGHT	*	CLEAN	648	ICE-CAPPED		COLD	380
CLEANED		CLEAN	648	ICY		COLD	380
DEWY	*	CLEAN	648	BRIGHT		COLORED	425
DIRT-FREE		CLEAN	648	BRILLIANT		COLORED	425
DISINFECTED		CLEAN	648	COLORED	*	COLORED	425
FRESH		CLEAN	648	COLORFUL	*	COLORED	425
IMMACULATE		CLEAN	648	DEEP-COLORED		COLORED	425
POLISHED		CLEAN	648	DYED		COLORED	425
PURE		CLEAN	648	GLOWING		COLORED	425
SHINING		CLEAN	648	TINGED		COLORED	425
SHINY	*	CLEAN	648	TINTED		COLORED	425
SPOTLESS		CLEAN	648	VIVID		COLORED	425
STAINLESS	*	CLEAN	648	ALBINO		COLORLESS	426
STARCHED		CLEAN	648	ASHEN	*	COLORLESS	426
IMPENETRABLE		CLOSED	264	ASHEN-HUED		COLORLESS	426
IMPERMEABLE		CLOSED	264	ASHY	*	COLORLESS	426
IMPERVIOUS	*	CLOSED	264	BLANK		COLORLESS	426
IMPOROUS		CLOSED	264	BLEACHED		COLORLESS	426
CLOUDY	*	CLOUDY	355	COLORLESS	*	COLORLESS	426
HAZY	*	CLOUDY	355	DECOLORED		COLORLESS	426
MISTY	*	CLOUDY	355	DIM		COLORLESS	426
ADHESIVE	*	COHESIVE	48	DINGY	*	COLORLESS	426
CLAMMY		COHESIVE	48	DISCOLORED		COLORLESS	426
CLINGING	*	COHESIVE	48	DULL	*	COLORLESS	426
CLOSE		COHESIVE	48	FADED	*	COLORLESS	426
COAGULATE		COHESIVE	48	FADING		COLORLESS	426
COHESIVE	*	COHESIVE	48	GLASSY	*	COLORLESS	426
COMPACT		COHESIVE	48	GLOSSLESS		COLORLESS	426
CONCRETE		COHESIVE	48	GRAY	*	COLORLESS	426
FROZEN		COHESIVE	48	HUELESS		COLORLESS	426
GLUEY		COHESIVE	48	LACK-LUSTER	*	COLORLESS	426
GUMMY	*	COHESIVE	48	LEADEN	*	COLORLESS	426
MOLDING		COHESIVE	48	LIGHT-COLORE		COLORLESS	426
MONOLITHIC		COHESIVE	48	LUSTERLESS		COLORLESS	426
SOLID		COHESIVE	48	MOUSY	*	COLORLESS	426
STICKY	*	COHESIVE	48	PALE	*	COLORLESS	426
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